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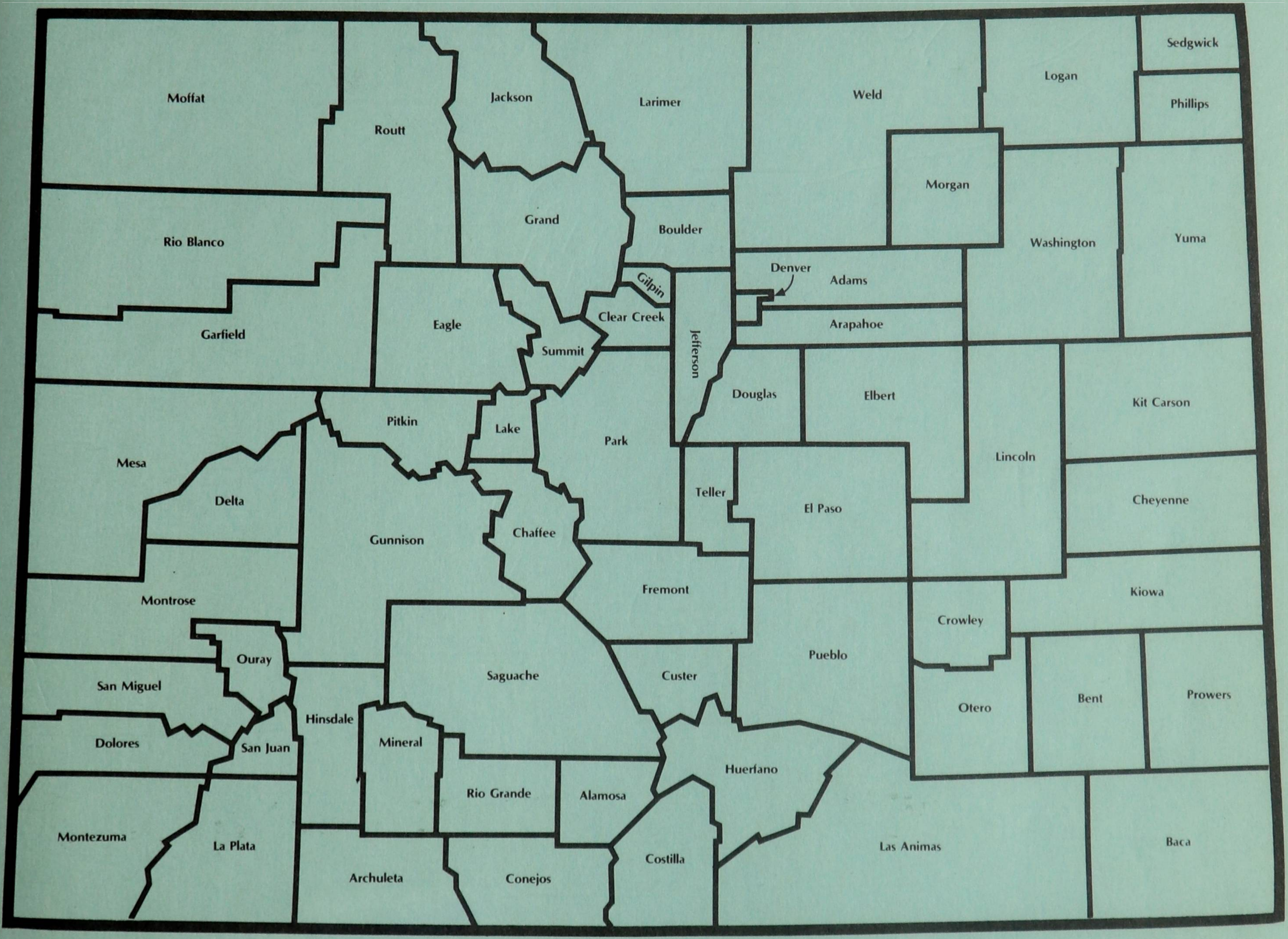
STATE OF COLORADO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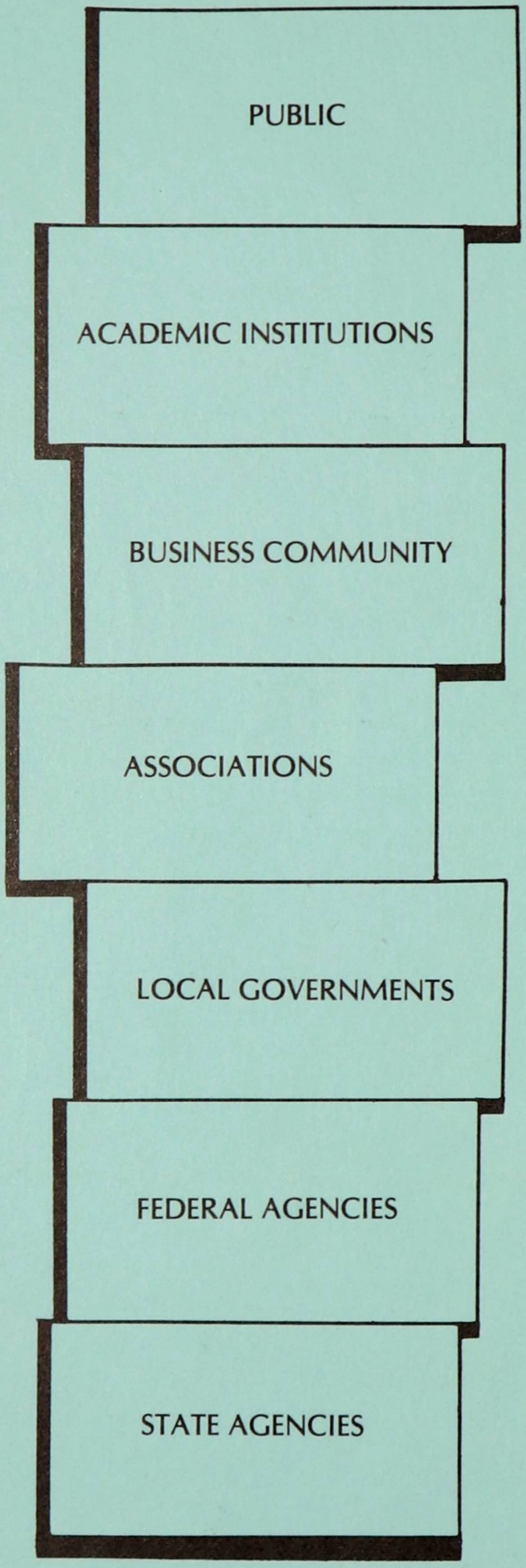
GOVERNOR'S FORUM ON GEOGRAPHIC INFORMATION

OCTOBER 6TH, 1987

“BUILDING COLORADO’S INFORMATION FOUNDATION”



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STATE AGENCIES

GOVERNOR’S FORUM ON GEOGRAPHIC INFORMATION

STATE OF COLORADO

EXECUTIVE CHAMBERS
136 State Capitol
Denver, Colorado 80203-1792
Phone (303) 866-2471

1876

Roy Romer
Governor

January 14, 1988

Dear Fellow Coloradan:

I would like to thank you for your participation in the Governor's Forum on Geographic Information.

We hosted this forum to explore opportunities to promote and foster better coordination of geographic information technology between government, academia and private industry. Judging from the outstanding attendance and the quality of presentation, I would call the forum an unqualified success. Colorado and members of the private sector have published the proceedings from the forum to continue this communication. I hope you find them informative.

I encourage you to continue your important work on this valuable technology by sharing resources and improving our collective knowledge base.

Sincerely,

Roy Romer

Roy Romer
Governor

RR:tjh

PREFACE

The Governor's Forum on Geographic Information was held on October 6, 1987 at St. Cajetan's Center on the Auraria Campus in Denver. Approximately 300 people attended the Forum representing the business community, local governments, state agencies, academia, federal agencies and numerous professional associations. A separate participant list was prepared and is available from Roberta Smilnak at Metropolitan State College (556-3115).

"Geographic Information Coordination" offers a common theme and focus for Coloradans to work toward to help individuals, public and private organizations, and the State as a whole. By sharing and developing compatible information, its usefulness can be maximized for more cost effective government and better quality decision making. Colorado is unique with its central location in the nation, beauty and human resources. Coordination and development of geographic information offers a mechanism and opportunity to help strengthen these qualities in the future. The Forum was held to gather interested Coloradans together to discuss these ideas and related activities throughout the state. The common theme and purpose of the Forum was to:

- Understand and develop Colorado's geographic information needs, resources, activities and opportunities.
- Promote partnerships and coordination between state, local and federal agencies, as well as academia and the business community.
- Determine a proper role for state government in coordination of Colorado's geographic information.

Editor's Note:

The Forum was held as part of a geographic information coordination project initiated in April, 1987 and sponsored by Lowell B. Jackson, P.E., Executive Director of the Colorado Department of Highways in 1987. Support for the Forum was provided by the Department, with assistance from many Coloradans representing numerous other entities in the State as listed in the Acknowledgements section of the Proceedings. Personal thanks and gratitude are offered to all who helped and participated in the Forum, and particularly to Lowell Jackson who made the Forum possible.

Copies of this document are available from Craig Kurtz at U.S. West Corporation (793-6563).

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AGENDA AND TABLE OF CONTENTS

Page

Preface i

Acknowledgements ii

Agenda and Table of Contents iii

A. Setting the Stage

I. Opening and "Why Geographic Information (GI)?"
Lowell B. Jackson, P.E., Executive Director
Colorado Department of Highways 1

II. Developing Colorado's Opportunities and Direction in GI
The Honorable Roy Romer, Governor of Colorado 4

III. Building Colorado's GI Foundation--
Presentation of Last Quadrangle Map to Governor Romer
by Lowell Starr, Chief of National Mapping, USGS 6

B. Policy and Management Approaches to GI 7

I. Federal Perspective
Lowell Starr, Chief
National Mapping Division, U.S. Geological Survey . . . 8

II. Municipal Perspectives
James Griesemer, City Manager, Aurora 10

III. County Perspective
Gordon Tiffany, Mesa County Administrator 15

IV. Private Perspective
Brian Propp, Director, Strategic Planning, US West . . . 17

C. Learning from Governments Outside Colorado 19

I. GI Coordination Efforts in Other States
Lisa Warnecke, Geographic Information Coordinator
Colorado Department of Highways 20

II. State of Illinois
Tim Johnson, Information and Analysis Manager 22

III. City and County of San Diego
Bill Bamburger, Administrator
Regional Urban Information System 24

AGENDA AND TABLE OF CONTENTS (cont)

Page

D. Interorganizational Coordination in Colorado 30

Moderator: Carl Norbeck, Associate Director
Center for Public/Private Sector Cooperation,
University of Colorado/Denver

I. Denver Metro Network
Tom Clark, Vice President
Denver Chamber of Commerce 31

II. Denver Regional Council of Governments
Tom Simmons, Manager, Economics and Demographics, DRCOG . 34

III. Adams County and AT&T
Les Trujillo, Adams County Administrator 36

IV. Boulder County and . . .
Ed Tepe, Land Use Director . . . . *

V. Metropolitan State College and . . .
Alan Freeman, Co-Director of Institutional Research . . 46

VI. Colorado's Opportunities in Geographic Information
Jerry Horak, Councilmember and Former Mayor, Fort Collins
Program Manager, TGS Technology, Inc. 47

SECTOR PANELS: USES AND PERSPECTIVES 48

E. Business Community 49

Moderator: Sue Morgan, Assistant Director
Colorado Advanced Technology Institute

I. Petroleum Information
Ron Dietsch, Senior Vice President 50

II. Harrison Resource Corporation
Craig Harrison, President 51

III. HDR Infrastructure
Jack Miller, Vice President 52

AGENDA AND TABLE OF CONTENTS (cont)

Page

IV. Utility Notification Center of Colorado
Dan Tekavec, President 53

V. SRM Corporation
Jim Kent, Chief Executive Officer . . . . *

VI. Martin Marietta Information and Communication Systems
Lee Aguiar, GIS Manager 55

VII. Public Service Company
Dawn Sudmeier, Information Systems Division Manager . . . 56

F. Local Governments 59

Moderator: Marlene Fish
State Representative, House District 23

I. City of Colorado Springs
Kelly Means, Manager
Integrated Management Information Systems 61

II. City of Longmont
Jack Myers, Civil Engineering Manager 62

III. City of Fort Collins
Curt Miller, Project Manager. 64

IV. Denver Water Board
Lee Cesario, Project Director 66

V. Regional Transportation District
Robert Browning, Assistant to General Manager for
Information Systems . . . . *

AGENDA AND TABLE OF CONTENTS (cont)

Page

G. Federal Agencies 68

Moderator: Billie Swenson, Mapping Director
Jefferson County

I. US Geological Survey
Lee Aggers, Special Assistant--Requirements
National Mapping Division 69

II. National Oceanic and Atmospheric Administration
David Hastings, Chief, Data Integration and Remote Sensing
National Geographical Data Center 72

III. Bureau of Land Management
Steven Gregonis, Chief, GIS/Graphics
Colorado State Office 78

IV. Environmental Protection Agency
Larry Svoboda, Chief, Environmental Monitoring
and Assessments 79

V. National Park Service
Phil Wondra, Chief, GIS Division 81

VI. Western Area Power Administration
Charles Landes, Chief, Branch Acquisition 85

VII. US Bureau of the Census
Matt Engler, Geographic Coordinator 87

VIII. Soil Conservation Service
Dale Holden, Soil Data Base Coordinator 88

H. State Agencies 90

Moderator: Ken Torp, Executive Director
The Centers, Graduate School of Public Affairs,
University of Colorado, Denver

I. Administration
Regina Kilkenny, Legislative Liaison 91

AGENDA AND TABLE OF CONTENTS (cont)

Page

II. Highways
Greg Fulton, GIS Manager 92

III. Natural Resources
Ron Cattany, Acting Deputy Director 94

IV. Local Affairs
Marv Koleis, GIS Manager 96

V. Public Utilities Commission
James Spiers, Executive Secretary 98

VI. Historical Society
Leslie Wildesen, Vice President 99

VII. Higher Education
Charles Manning, Deputy Executive Director . . . . *

VIII. Health
Tom Tayon, Environmental Information Center Coordinator . 101

I. Wrap Up 104

Ken Torp, Executive Director
The Centers, Graduate School of Public Affairs
University of Colorado/Denver

J. Tables

I. Geographic Information Coordination in the States 106

II. Geographic Information Systems
Activities in the Federal Government 109

III. Geographic Information in Colorado State Agencies 124

IV. Geographic Information in Colorado Counties 126

* = Comments not Submitted

A.I. OPENING AND "WHY GEOGRAPHIC INFORMATION (GI)?"

Mr. Lowell B. Jackson
Executive Director
Department of Highways
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Denver, CO 80222
757-9201

A wide variety of the information we use daily can be referred to by its geographic location. Thus, a definition of "geographic information" or GI is any data that can be referenced to a specific location.

It includes distribution and use of natural resources; patterns of land use; descriptions of infrastructure; property rights, ownership, regulations and valuation; and socioeconomic information, such as health, employment, housing and voting habits of people. This information is available in many automated and manual forms such as maps, aerial photography and satellite imagery, but also in many tabular and textual reports. Many new technologies are being applied to GI to improve its accuracy management and usefulness.

We have representation at this forum from all levels of government, academia, and the business community. We all use geographic information. A great deal of public funds are spent on geographic information, and some estimates are as high as 90 percent of data used by government can be referenced by location.

Often governments, agencies and businesses do not know what kinds of information others have, so we develop our own. We have 1,856 units of government operating in Colorado today. Each has one or more purposes, programs, reporting requirements, information systems and taxing authorities. We network and learn from each other, but it is increasingly difficult to be informed about the increased number of data sources. We are experiencing a proliferation of information and use of related technologies for individual projects, but it is often not possible to be merged for statewide policy uses. We are also risking inaccurate, incompatible and incomplete information. These efforts are costing Coloradoans time and money.

All levels of Government are facing some serious problems:

o <ins>Our decisions are increasingly complex and multi-dimensional</ins>. They also have increasingly significant impacts, thus requiring integration of data from various sources. Many of our decisions, problems and needs relate to how we use our land. But too often we compile information that is useful for only one project. Many taxpayer dollars have been spent to develop information for a new airport, convention center and other public investments, but we often cannot integrate these information resources for other purposes. Our problem is often not a lack of information, but an organized way to best use, reuse, and understand that information.

- Governments are increasingly required to do more with less. The public and elected officials are requiring all governments to do more with less resources and time. Governments are also required to be fiscally and socially accountable, and more efficient. This is all as our budgets are being cut. There is and will be a growing frustration at all levels within our governments as we attempt to meet these conditions.

This dichotomy of increasing needs and demands with resource reductions means we need improvements in three areas:

- First, as is the theme of this forum, we need to build and invest in a multi-purpose information foundation for and about Colorado. Much of what we value about our state and our strength in the national and international economy is based on geography. Shared knowledge about our state can help us protect and maximize these qualities. Instead of single purpose or project information investments, we can maximize our expenditures by ensuring these resources can be used for other purposes. Information can be developed as a strategic resource for the state, but it has largely been undercapitalized to date. An authorizing environment is needed at the state level to build such a multipurpose resource.

- We must work together and consider the needs of other government entities when we develop our information resources and systems. Often an additional field or "hook" to reference information by location can help others both in and outside our own organization. This is where geographic referencing holds much opportunity. Referencing state and federal information by location reduces it to a useful scale for local governments, businesses and others. Such a reference also provides a link between data developed for differing purposes, helping to ensure compatibility of information for a variety of purposes. By working together, we can reduce redundancy, increase compatibility and jointly develop Colorado's information base while meeting our individual needs.

- Our third area of effort should be to maximize our existing and potential technological capabilities, such as geographic information systems, remote sensing and satellite positioning, as well as general data processing and telecommunications. Our initial review of geographic information technologies reveals some excellent initiatives in the state. We have award-winning systems in state agencies for satellite water monitoring and minerals management. Colorado's Public Service Company was an early innovator, investing over $25 million in its facilities management system. Energy companies have often developed geographic information technologies with many headquartered here in Colorado. Nationally, the cost of the Landsat Satellite program was solely justified by the amount of energy resources discovered by this satellite imagery. In Colorado, counties including Boulder, Adams, El Paso and Mesa and the cities of Colorado Springs, Aurora, Fort Collins and Longmont have or are considering the adoption of geographic information technologies. These initiatives represent significant investments to build multi-purpose information foundations. As we will learn at today's forum, such investments have resulted in proven benefits to improve public sector effectiveness and decision making.

As many of you know, the Department of Highways is implementing a geographic information system or GIS as a tool to manage and display geographic information. We are also using geographic information to refer to and integrate the vast array of information we generate. We use geographic information on an operational level to reconstruct, realign and maintain our roadway system. The GIS will help us at this level and we also plan to use it for monitoring traffic, evaluating patterns, integrating roadway data relationships, route optimization, corridor analyses and site selection. Already our accuracy and reliability of date have been improved, and we expect cost savings of over $3 million in the next ten years when compared to manual operations. We have also created products and conducted efficient analyses never possible before.

As a state, we have many opportunities to maximize the usefulness of geographic information technologies. Recently, these technologies have been utilized to address specific state needs, such as our supercollider, airport, and E470 proposals. However, their information resources have been developed individually. Efforts to merge these data sets with other data in federal, state, and local agencies would help create a multi-purpose resource for many uses in the future without having to start over for each new project.

During the last few months, we have initiated an effort to identify geographic information resources, activities, needs and opportunities throughout Colorado and evaluated past coordination efforts to build upon these experiences. Today's forum will help identify current initiatives in Colorado and give us opportunities to learn from other governments and each other. We are attempting to build a cooperative effort among agencies, governments, academia and the business community. Your ideas and help are needed to proceed.

In summary, I believe coordination of geographic information is an excellent goal for us to work together to achieve. We need to point our resources to this goal. I suggest to you that the key is the commitment, resources and authorizing environment to get this job done.

A.II DEVELOPING COLORADO'S OPPORTUNITIES AND DIRECTION IN GEOGRAPHIC INFORMATION

The Honorable Roy Romer
Governor of Colorado
State Capitol Building
Denver, CO 80203
866-2471

I would like to thank the audience for their attendance and contributions in making Colorado a leader in software technology.

Practically everything government does is related to a specific geographic location, in particular, natural resources, utilities and transportation infrastructure, socioeconomic characteristics, and land use. Most of this information can be computerized. Through coordination of this data, we can paint a more accurate picture of the state from which to make better public decisions.

Colorado is becoming a national and international leader in some information technologies, particularly environmental and atmospheric sciences. CSU was recently awarded a $500,000 grant to do remote-sensing research, and the Bureau of Reclamation is relocating from Washington D.C. to Denver. Both are examples of the reputation Colorado is achieving. With our unique location and educated work force, we can become a national center for geographic information.

Geographic information has useful applications for economic development. For instance, if a business is interested in locating to Colorado, a comprehensive geographic information system could provide information on the location of all the 100-acre industrial zoned parcels, access to heavy rail, driving time to a major interstate, service boundaries of major utilities, and the educational makeup of the labor force.

Currently, geographic information comes in the form of maps, textual records, remote sensing (satellite imagery and serial photography) surveying and geographic information systems. Similar to what you see as a pilot, geographic systems are a tool for having a birds-eye view of the entire landscape of Colorado. As a former land developer who used to stake out sections of land, I appreciate the need for accurate geographic information.

Geographic information can help improve public sector productivity. This is done two ways:

1) Reduce overlapping efforts and inefficiency. Mapping efforts in state, local or federal government should be coordinated to reduce redundancy. Geographic information technologies will replace time consuming and inaccurate manual mapping techniques with automated systems

2) Decision making. Policy makers can make better decisions if they see the whole picture, not just a slice of the picture.

A great deal of public funds are being spent by state and other governments on geographic information technology. A recent DRCOG study concluded that millions of dollars have been spent in the metro area alone. State efforts must be coordinated with local and federal government which are often ahead of state government on this technology.

Considering state government's limited resources yet multiple investment needs, should geographic information become a high priority? While we should encourage innovation, we must differentiate between information gathering and information application. We are not developing a toy, we are developing a tool that must be cost-effective and useful to decision makers.

I ask you for help in ensuring that we achieve this goal.

Thank you again for your attendance and participation in this worthwhile day of events.

A.III. BUILDING COLORADO'S GI FOUNDATION - PRESENTATION OF LAST QUADRANGLE MAP TO GOVERNOR ROMER

Mr. Lowell Starr, Chief
National Mapping Division
U.S. Geological Survey
516 National Center
Reston, VA 22092
(703) 648-5748

This presentation celebrates the completion of the State's primary topographic map coverage as a key base for Colorado's geographic information foundation. This 7 1/2 minute, 1:24,000 scale series, or quadrangle maps, as they are commonly referred, are used as a geographic reference base for many governmental, business and public recreation activities. This completed series includes 1,899 map sheets to cover the entire state.

Completion of this series marks over 60 years of cooperation between state and federal agencies in Colorado. During this time, over $2 million in state funds were matched by over $2 million in federal funds to develop base maps for Colorado. This cooperative effort led to the first agreement between USGS and a state (Colorado) to develop an intermediate scale map series. This 1:50,000 scale coverage, with 202 sheets to cover the state, was completed in 1980, with state and federal matching funds.

Colorado's geographic information foundation is being built by these and other cartographic products. A current list of Colorado mapping programs and available products for USGS, and completion dates include:

- o 1:24,000-scale topographic coverage for the state, completed in 1987.
- o 1:24,000-scale orthophotoquads for 66 percent of the state.
- o 1:50,000-scale county maps for the state in 1980.
- o 1:250,000-scale land-use/land-cover for the state in 1987.
- o 1:100,000-scale plainmetric state coverage in 1986 and 1:100,000-scale digital line graph transportation and hydrography coverage in 1987.
- o 1:500,000-scale state topographic base map.

B. POLICY AND MANAGEMENT APPROACHES TO GEOGRAPHIC INFORMATION - PREFACE

Organizations are increasingly adopting geographic information technologies, but with increasing risk of redundancy and incompatibility even within a single organization. Most information development and investments are made for specific projects or purposes rather than organization wide, multipurpose information resources. Increasing expenditures are spent on information development. At the same time, policy makers and managers in public and private organizations alike are becoming increasingly aware that quality, accessible, timely and multifunctional information is essential for many operational and strategic needs.

While investments in information technology are increasing, full utilization of technological capabilities is often suboptimized. Relevant research about the public sector reveals an increasing 10 to 15 year gap between information technology development and its widespread adoption. It also has been concluded that institutional factors, such as policy, management and organizational approaches, influence information technology adoption to a greater degree than technological capabilities.

Traditionally, information technology has been the jurisdiction of data processing or management information systems functions. An increasing trend is the recognition that information, rather than technology, must be considered and developed as a key resource, like personnel and capital, in the emerging information society. To be cost effective and of greatest usefulness, information must be considered as an organization wide resource, rather than the domain of a single agency or department. However, policy, legal and organizational frameworks, and traditional capitalization mechanisms, often encourage and maintain fragmented information systems rather than multipurpose information resources. Institutional innovation is needed to build such resources and maximize technological capabilities.

Coordination needs are evident in all forms of information, but particularly in the development of geographic information resources as many different governments and agencies develop information about the same land. Multiorganizational cooperation and joint development between governments and the private sector will result in reduced redundancy and the greatest value for taxpayer investment. Implementation of compatible or joint resources requires appropriate policies and management frameworks. It is also necessary that organizations have leaders who are committed to building such resources.

Colorado's state government has much to learn from the policy and management approaches of other governments and businesses operating in Colorado. These organizations are recognizing, developing and capitalizing information as a key strategic resource to improve effectiveness. Partnerships between leaders and different sectors can emerge after organizations have adopted similar goals, philosophies and principles to share and maximize information development.

B.I. FEDERAL PERSPECTIVE - U.S. GEOLOGICAL SURVEY

Mr. Lowell Starr, Chief
National Mapping Division
U.S. Geological Survey
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(703) 648-5748

The Federal Interagency Coordinating Committee on Digital Cartography (FICCDC) was established in the Office of Mangaement and Budget (OMB) Director's memorandum of April 4, 1983, and extended by the OMB memorandum of March 18, 1986. The FICCDC is mandated to recommend procedures and programs which would facilitate the coordination of Federal agencies' digital cartographic activities; establish and promulgate standards and specifications for the production of digital cartographic data; and report to the Director of OMB, on a systematic basis, on the activities and accomplishments of the FICCDC. Specifically, the FICCDC is charged with:

- o Facilitating the Coordination of agency digital cartographic activities and the exchanging of data, by formal and informal means.
- o Collecting and compiling information on Federal agencies' digital cartographic activities.
- o Determining which categories of digital cartographic data are to be included in the National Digital Cartographic Data Base of the U.S. Geological Survey, assisting the Survey in establishing and publishing standards and specifications for the data, and assisting in establishing priorities for digital cartographic data production.
- o Developing and adopting, for use by all Federal agencies, common standards of content, format, and accuracy for digital cartographic base data to increase its interchangeability and enhance its potential for multiple use.
- o Facilitating the economic and efficient application of digital cartographic data through the sharing of experiences involving applications.

The FICCDC consists of a Steering Committee and five working groups: (1) User Applications, (2) Technology Exchange, (3) Requirements, (4) Standards, and (5) Reports, all with multiagency representation.

The eleven-member Steering Committee is responsible for guiding the activities of the various working groups and for coordinating the work and output of the FICCDC.

The working groups carry out the tasks of the FICCDC by accomplishing the following primary tasks:

Requirements: Identifies Federal requirements for digital cartographic data and provides the coordination and collection priorities to assist in ensuring that these needs are met.

Standards: Provides a mechanism for the development and review of digital cartographic data standards within the Federal Government that will facilitate data interchange and avoid or minimize the costs of conversions and incompatibilities; this includes the selection of the multipurpose data categories that the U.S. Geological Survey will collect, along with data standards and specifications.

User Applications: Facilitate the economic and efficient application of digital cartographic data through the sharing of experiences involving applications.

Technology Exchange: Serves as a forum for the exchange of information and ideas on technology and on methods for collecting, managing, and using digital cartographic data; monitors evolving technology and identifies areas in need of further research and development.

Reports: Monitors Federal computer mapping efforts in order to avoid duplication and to promote effective uses of digital cartography; collects, maintains, and reports to OMB summary information on agencies digital data program, including the resources being expended.

A similar coordination structure is in effect for the Department of the Interior, known as the Interior Digital Cartography Coordinating Committee.

To help get a better understanding of GIS across the Federal government, the FICCDC conducted a government wide GIS survey (Table II). The governmentwide survey, was made up of 10 questions. It was sent to the FICCDC, the IDCCC, and 10 additional organizations. A potential population of approximately 50 organizations could respond. Of the 30 organizations which responded, 24 of them are using GIS in some manner. Approximately a third of the responding agencies are using GIS every day throughout their organization. Seven organizations currently have a written published GIS policy. There are similarities in GIS use in broad terms, but a wide range of specific uses. A number of organizations have classification standards. Eight organizations have data entry standards. Five agencies have programs to manage standards. Mini and micro computers are the dominant hardware, but there is diversity. The overall percentage of use in terms of software are about equal between public domain and commercial. Most GIS activities is currently funded under mission-related programs. The survey was not scientific, but it was a snap-shot of current activities within 30 agencies of the Federal government.

B.II. MUNICIPAL PERSPECTIVE - CITY OF AURORA

Mr. James Griesemer
City Manager
City of Aurora
1470 S. Havana
Aurora, CO 80012

Thank you, I am very pleased to be here. Sincere congratulations go to Governor Romer for his leadership, and to Lisa Warnecke and others for their initiative in developing this conference. I think sometimes, not often but occasionally, we embark on activities which are much more important than they seem. That is, activities which at one level have clear tangible value, but at a deeper level have much greater significance. I think this is such an activity.

My purpose here today however, is to touch on policy and management perspectives on Geographic Information (GI). Therefore, I'd like to briefly share with you:

Policy/Resource Perspective:	I. A resource policy perspective
Data Management Perspective	II. What Aurora has done on geocoding
	III. Our progress on digital mapping
Horizon Lifting Opportunity	IV. A paradigm shift opportunity in local government
	V. Role for the State

My background has been in City Management for 20 years. In addition, I have written extensively about computing in local government, and began implementation of geocoding in 1979. Aurora has a population of 240,000 with a $250 million budget and we are moving ahead in the area of geographic information development.

I. Resource Policy Perspective

I come at this with a world view of relative resource scarcity in the public sector. I am not talking about Colorado's lanquid economy here, but rather, the declining growth of public sector resources as a percentage of GNP. As governments, we have to do more with less (creatively). This is not necessarily bad at all as it enables us to:

- o Develop new institutional arrangements
    - --Intergovernmental agreements
    - --Regional services
- o Set priorities
- o Use resources more efficiently

Therefore, GI is important, not simply because it is interesting and exciting, but because it is consistent with our basic effort to respond to the public sector environment--to manage resources more efficiently and effectively. It is, in short, relevant. And it should, therefore, be fairly high on our list of state and local priorities.

At the local level, it is clear that cities are involved in computerizing large quantities of information. Computerized information -- much of it geographic in nature -- is growing astronomically.

It seems that every person needs some type of geographic information--whether it is a city resident, city council member, business owner, builder, developer, fireman, engineer, school teacher, tourist, police chief, city manager or governor.

For municipalities, then, there is a growing realization that geographic information is a resource that must be managed because:

> Much of local government information -- and the functions that this information supports -- is land-based:
>
> Planning (plans review, mapping and demographics)
> Transportation (transit routes, roadway design, snow plowing)
> Utilities (water distribution, wastewater and storm drainage)
> Code Enforcement (animal control, building inspection)
> Emergency response (police and fire dispatch)
>
> Geographic information is a cross-cutting element of city services. Police, fire and ambulance services respond jointly to requests for emergency services at a particular location. Inspection personnel assigned to a public works project work at the same site as the engineers overseeing the project. Ultimately, it is this cross-cutting dimension which may be most useful.

Information about geographic locations is essential to municipal operations. With recent advances in computer-based technology, geocoding and geoprocessing have emerged as tools with enormous potential for local governments striving to manage geographic information.

II. Geocoding

Earlier this year, after months of work, Aurora developed and adopted a geocode, a standard way of referencing geographic information throughout City operations. From a policy and managerial standpoint, this paved the way for some significant new capabilities.

- o It allows the analysis of disparate information: we can correlate the incidence of fires with the type of crime in a particular neighborhood.
- o Promotes ad-hoc information retrieval: we can respond to a citizen's request for information on the incidence and type of crime in a particular neighborhood.
- o Facilitates costing of services by area: we can determine how much we are spending on community development in the north, as opposed to the south, part of the city.

III. Computer or Digital Mapping

Much of the power of this city-wide geocode, however, will be realized with the city wide computerized base map being developed jointly by the Public Works and Utilities department. Today's manual systems of mapping are totally inflexible as far as information management is concerned. In order to make geographic information systems work, they need the spatial relationships possible through automated mapping systems. Tomorrow's computerized or digital maps will allow us to view the city's data in ways never before possible.

The geocode and the computerized map can be used as a management tool for retrieval, analysis and display of spatial data. Geographic information will offer opportunities to integrate systems, such as using the Computer Aided Mapping and the Police/Fire Computer aided dispatch system. Police cars or other emergency equipment may be routed using the best route taking into account impedances such as roadway construction.

IV. Local Government Opportunity

Perhaps most importantly, the geocode opens up a totally new concept in municipal management: dynamic resource allocation.

Recall that I said geographic information costs across functional lines. The geocode allows us to take advantage of that. Here's an example. Aurora, like most other cities, has a department devoted to code enforcement. That means that on any given day, we have a couple dozen inspectors out on the streets enforcing city building and community maintenance regulations. But why limit them to these functions? If they see a suspicious person in a particular neighborhood, shouldn't they act as a spotter for the police and report it?

Up until now, that wasn't possible. Aside from a sort of "not my job" mindset, which we are changing, there were practical barriers: what was a legal description, say, to the inspectors was a street address to the cops. They didn't talk the same language. The geocode eliminates this barrier and paves the way for an entirely new way of managing operations.

V. State Role

So far, I've talked only about geographic information systems as they relate to a single municipality. But cities don't operate in a vacuum. Public administration today is bounded by resource limitation. It is constrained by a less-government mentality, and increasingly pressed to provide services formerly provided by the federal government. There is as a result, a growing interdependency between public sector organizations and other public and private organizations. For example:

> Aurora has boundary agreements with Denver in which each municipality agrees to assist the other in the event that it can respond in a more timely fashion to an emergency along the cities' borders.
>
> Several agencies -- among them RTD, Adams County, Arapahoe County, and E-470 Authority -- now or will soon have geographic information systems in place. There is an enormous potential to eliminate redundant coding through the sharing of data and information.

Obviously, agreements like these are anchored in the sharing of geographic information. In these fiscally constrained times, it makes sense for such entities to cooperate in the coding and processing of geographic information so that our ability to provide services jointly and share information is enhanced.

The State can have a very important role in this cooperation. Specifically, it can facilitate on several levels:

o definition of terminology
o definition of data transfer standards
o definition of reliability of data (extremely important)

Private entities should also be involved in information sharing, such as:

o Cable TV
o Phone companies
o Public Service
o Hospitals

V SUMMARY

Geographic information systems are increasingly important in city management. But to cost-effectively realize the full potential of both geocoding and geoprocessing, cooperation and sharing among both public and private entities is needed, along with assistance by the State in setting basic protocols.

B.III. COUNTY PERSPECTIVE - MESA COUNTY

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County government has two faces. Counties are "local government," and are commonly grouped with municipalities in political science courses. But they are also "administrative areas" of the State, carrying out many State-mandated programs. Colorado counties do not have home rule; nor do they have a great deal of local discretion and flexibility.

For example, Senate Bill 35 allows low density development to occur without County, or State regulation. One of the ramifications of this is that a multitude of special districts develop within the county's jurisdiction. Population increases and utility demands sprout special districts, and this leads to complex multi-jurisdictional coordination needs, similar to a metropolitan area, but in a relatively rural, less populated area of non-urban experienced government institutions.

Mesa County includes the only urbanized area on the Western Slope and comprises 3,300 square miles. Between 1977 and 1982, Mesa County absorbed 10-15,000 new residents as a result of a boom in oil shale development and conventional oil and gas. This rapid growth focused on the county seat of Grand Junction, creating the predicament of increased urban demands upon a predominately rural infrastructure. The situation received an unprecedented response from the County and other jurisdictions in responding to infrastucture shortfalls in roads, bridges, water, sewer and schools.

The urgency of responding to these "boomtime" pressures resulted in inadequate coordination between various local jurisdictions which resulted in significant cost overruns in the many capital improvements made at the time. Mesa County has learned about the costs resulting from a lack of good geographic information. This last "boom" clearly revealed the need for a comprehensive, shared geo-database.

Mesa County has therefore begun work on the development of a county-wide integrated geographic information system (IGIS). This will be a cooperative effort involving federal, state, local government agencies, special districts and private utilities. When completed, the system will provide benefits to every function within the county area that uses or generates geographically related data.

But governments can't just jump into a technology as sophisticated and demanding as GIS without some preparation. Mesa County began its preparation in 1983 through the establishment of the Management Initiatives Team (MIT), a selected group of employees. Their mission was to aggressively seek and implement major operating economies throughout County government, including office automation. Since MIT began, new cost-saving programs have been developed, including Risk Management, microcomputers, digital telephones, engineering, innovative bridge programs, and centralized services, to name a few.

In 1986, the Board of Commissioners adopted a 5-Year Automation Plan to achieve "distributed" data processing among all County Departments and establish a county-wide geographic information system. The MIT process had been successful in implementing a number of cost-effective procedures, but the most important of those agenda items was the preparation of the County's officials and staff for the automation of the entire government. Mesa County is now prepared to cooperatively develop and implement a county-wide IGIS.

B.IV. PRIVATE PERSPECTIVE - U.S. WEST

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Geographic Information Systems

What is Geographic Information?

Data produced or collected pertaining to anything that is physical

A resource that exists, tapped or untapped

What is a GIS?

A tool to convert data into information

What is a GIS good for?

The ability to use geographical information to:

Discover opportunities
Take advantage of opportunities

Public Sector Perspective:

- Desire to streamline operations
- Responsibility to provide public assistance
- Need for infrastructure management
- Desire for economic development
- Desire for consistency in collecting and reporting
- Desire for interface with private sector, with the view that the private sector is the:
    - Primary resource base
    - Primary economic base
    - Primary employer
    - Primary source of growth

Private Sector Perspective:

- Desire access to information,
    - Easily
    - Inexpensively
- Desire cooperation,
    - With other private entities
    - With all public entities
- Desire for public disclosure,
    - Non-proprietary information should be accessible
- Desire for privacy,
    - Proprietary information must be protected
- Desire for synergy,
    - Distate for duplication of effort and resources
    - Coordination of public data
- Desire for standards and a common base of understanding
- Desire for interface with public-sector
- Desire to play a part; and benefit from economic development

Top-Down GIS planning:

- Strategic
- Tactical
- Operational

C. LEARNING FROM GOVERNMENTS OUTSIDE COLORADO - PREFACE

Numerous governments both in and outside this country are focusing increasing attention on geographic information as a perspective and framework to maximize the usefulness of and access to information. This is particularly true in other, especially smaller, western nations because careful stewardship and management of land is considered essential where it is acknowledged as a limited resource. Third world countries, often with aid from development organizations, are using geographic information technologies, to identify and manage their natural resources.

Other countries have developed recent reports and initiatives which are useful to Colorado. A September 1987 Technology Strategy study by the Province of New Brunswick identified GIS as one of four major program areas for development and stated this "is a critical strategic area which should be explored immediately." The Canadian government has declared their country a leader in the development of remote sensing and published a guide of industry capabilities in 1987.

In Great Britain, a May 1987 parliamentary study concluded that "government, as the main supplier and user of geographic information, will have a central role to play,...we emphasize the need for Government to give a lead." In addition, this study stated the full potential of GIS will only be secured by "coordinating the interests of the widely dispersed community of users".

The Council of Ministers of the European Community has begun a program to develop environmental information in a GIS framework to assist policy making. Numerous countries, most recently including China, Italy, and Jamaica, have begun national digital database development in a GIS framework. Activities are underway in many others as well.

In this country, we are learning that federal, state and local agencies are spending millions of dollars on the development and management of GI. Documentation and policy development in this regard is only in its infancy. The federal government, through the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC), has recently inventoried GIS activities in federal agencies (Table II) and this author has reviewed activities in state governments (Table I).

Local governments represent the largest aggregate expenditures in this regard, but overall knowledge of their activities is limited. Many excellent initiatives including data sharing and joint development are underway at all levels both in and outside the state. Colorado can learn from and build upon these experiences.

C.I. GI COORDINATION EFFORTS IN OTHER STATES

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The need and opportunities for coordination of geographic information are increasingly being recognized by state governments. States are in key roles to lead and effectuate GI coordination among public and private entities. Key areas of need include:

- A clearinghouse of information resources activities and contacts
- Interchange guidelines and standards
- Modernization of laws pertaining to land management
- A land base and referencing scheme to tie together information developed by different entities

Virtually all states have some level of geographic information technology adoption, with over two thirds, including Colorado, developing GIS in one or more state agencies. Natural resources and transportation functions most often use this technology, but its usefulness for other applications is expanding.

Over half of the states have one or more GI coordination groups, such as geographic names boards, state mapping advisory committees, GIS users groups, or land records reform initiatives. These groups are generally authorized by executive order or statuatory directive. A trend is recently emerging in some states to merge the directions of these groups into one effort or council. For example, such a direction was authorized by the Governors of Oregon and New Mexico in executive orders signed in 1987.

Approximately one third of the states have designated a specific state agency with a lead role, or developed a base mapping program for all state agencies. A few states have base mapping standards or formats to enable exchange of digital data between agencies. All states have some form or portion of a GI data center such as a Census Data Center affiliation with the U.S. Bureau of the Census, or Cartographic Information Center affiliation with the National Center located at the USGS. Only a few states have broadbased GI data centers or referencing schemes. Standardized parcel level property ownership maps and parcel identification systems are required or recommended by over two thirds of the states to support assessment functions.

The states have varying levels of resource commitments to GI. The State of Wisconsin estimated that over $135 million was spent in 1987 by all levels of government in this regard. Financial commitments to GIS development range up to over $1 million in Minnesota and Illinois. Personnel commitments range up to 40 FTE as in these two states.

A summary, a review of GI policy development, institutional frameworks and commitments, and technology adoption in the states reveals marked increases in activity in all aspects of GI development. Coordination efforts can be traced back to the beginning of this century, but have increased exponentially in the last few years due to increasing needs, expenditures, developments and opportunities. Legal directives are also increasing, with six states authorizing some form of GI coordination in 1987 through executive orders or legislative initiatives.

It is becoming increasingly recognized that states have a responsibility, opportunity, and key role to coordinate GI among their agencies and other public and private entities.

C.11. STATE OF ILLINOIS

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Illinois' Department of Energy and Natural Resources (ENR) is a multi-functional agency dealing with issues related to the state's natural resources, the environment, energy development and conservation, and economic development activities.

GIS APPLICATIONS AND SOFTWARE:

The GIS has become an integral part of ENR's day to day operations. In addition to using the GIS for ENR program applications, GIS applications have been performed for numerous state agencies including the Departments of Commerce and Community Affairs, Transportation, Environmental Protection Agency and Public Health. GIS applications have also been performed for local government agencies in DuPage, Kane, McHenry and Lake (on-going project) counties. Approximately 50 staff use the GIS on daily basis. Major software packages that have been installed on the GIS include:

Major Software Packages - 14 installed or ordered:

- PRIMOS rev. 20.2.2 on 9955 Mod 2
- PRIMOS 20.2.2 on the 750
- PRIMENET, FTS X25 on both machines
- ARC (Versions 3.1 and 3.2.1 and 4.0 BETA)
- GRID
- GRID/TOPO
- INFO (Version 9.3.1)
- TEXT
- Minitab
- ELAS
- EMHASP
- IGL
- Surface II
- TERMS
- FORTRAN 77
- NETWORK (Versions 3.1 and 3.2)
- MIDASPLUS
- TIN (Version 3.2)
- ERDAS

GIS BENEFITS:

As stated above, the GIS is an integral part of ENR operations. Its use has enabled our department to more effectively analyze and manage natural resource, environmental, economic, and demographic data. In addition, numerous cooperative projects with private sector companies as well as federal, state, and county agencies have been conducted resulting in increased recognition and funding for our department.

MANAGEMENT AND FUNDING:

The operations of the GIS are managed by a committee made up of a representative from each program division and the assistant director of ENR. A systems analyst, a programmer and a 1/2 time applications person manage the day-to-day operations of the system. Support includes federal and state funds as well as monies received from private sector companies for GIS services.

APPROACHES:

Our Department tries to be as flexible as possible when it comes to GIS partnerships. We have worked on projects with public, private, and academic organizations under numerous relationships.

GI COORDINATION:

In many ways, Colorado is farther along in terms of GI coordination than Illinois. That was evident from the attendance at the Governor's Forum. With the amount of interest there is in GI technology, I would suggest GIS development in Colorado be directed by an independent organization made up of representatives from both the public and private sectors. The charter of this organization might be to develop GI applications related to economic development for Colorado. GI analysis related to transportation, public health, environmental protection, natural resources and demographic issues would also be included since they impact and are impacted by economic development. Such an independent organization, with some early successes, should be able to attract broad-based funding support from both the public and private sector.

C.III. CITY AND COUNTY OF SAN DIEGO

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The San Diego Regional Urban Information System (RUIS), which began in 1984, is a cooperative effort of both the City and County of San Diego to develop a geographic-based information system. RUIS is a response to the current environment which has local governments in a three-way squeeze:

- Problems are increasingly complex. In San Diego, policy makers are trying to deal with managing and controlling growth, an inadequate freeway system, a decaying sewer system, the destruction of natural resources and a myriad of other problems.
- Costs of government are increasing. The costs of the services provided by local government, typically labor intensive, are increasing faster than the overall rate of inflation.
- Tax revenues are not keeping pace with costs. In California, tax and expenditure limitations are severely squeezing local government finances.

Given these conditions, the City and County of San Diego, like local governments elsewhere, are searching for ways to improve services while keeping budgets in line. An integrated Geographic Information System (GIS), developed jointly by both agencies, is seen as a step in that direction. A GIS, based on common data base, can cost-effectively support many government functions. For example, a street management system developed in the Public Works Department can support Police and Fire computer aided dispatch as well as transportation planning. A land records management system created for tax assessment can also be used to support building permit and planning functions. GIS technology is being developed in many metropolitan areas in the U.S. In fact, in a survey of their municipal customers, IBM found that geographic information management is one of the top priorities of cities in the U.S., ranking second only to infrastructure management. This is not surprising when you realize that 85% of all data used within local governments is geographic in nature.

The geographic information which RUIS will automate, will include numerical and text information and also graphical map information. Local governments create and use more maps than any other segment of our society. Maps are used to record property ownership, public rights-of-way, utility locations, zoning, and flood plains.

By integrating the automation requirements of as many as 28 different departments in the City and County, RUIS will be able to provide better information for management and policy-level decision making.

One of the first tasks undertaken by RUIS was to develop an understanding of the current and future land based information needs throughout the City and County. With the help of a consulting firm and a Task Force consisting of city and County departments, an 18-month study was conducted to identify information requirements and automation needs. Over two hundred staff members, from counter staff to department heads, were interviewed. Based on these interviews, alternative ways of meeting the land-based information requirements were identified and evaluated. This resulted in a conceptual design for the system. Then a long-range implementation plan provides the blueprint for the development of RUIS over the next 10 years.

When fully implemented, RUIS will consist of a central data base, geographic information management hardware and software, and 24 application programs. The data base will include both computer maps and related tabular information. Five general types of information have been identified.

1. Land Records will include subdivision lot and parcel boundaries, plus information about ownership, land use, planning and building permits, zoning and other information.

2. Street Network information about every street in the County will be maintained in the Street Network Data Base. The street network data base will include information about road characteristics, street lights, street signs, maintenance, traffic accidents, traffic volumes and a variety of other stress-related features.

3. Network Facilities data includes information about the water and sewer systems, such as pump stations, flow characteristics, maintenance records, fire hydrants, and meters.

4. Environmental Data includes soils, flood plains, land cover, slope, geological hazards, airport noise, natural resources and other environmental characteristics.

5. Area Data includes information about jursidictional and statistical boundaries. For example, the area data base will include information about all city and special district boundaries, police beats, fire demand zones, community planning areas, and census tracts.

The Base Map will provide the means of tying all of the other map information together. The base map will ensure that each of the other map layers can all be registered properly with one another.

Information will be put into this data base through the normal daily transactions of the departments within the City and County. This will be done by developing "application modules" which will automate some of the processes which are now being performed manually.

The RUIS conceptual design identified 24 application modules. Each application module will automate existing manual processes. While the automation itself should improve staff efficiency, an added benefit will be that information collected by the application modules will become part of the central, shared data base. As a result, it will be available to other departments.

RUIS is envisioned as a long-term work program, with a phased development to occur over the next 10 years. Each year new capabilities will be added according to the overall system design. Each application will stand on its own, so we don't have to wait for 10 years for the system to become useful. In fact, one of the primary functions of RUIS is to coordinate the automation of geographic systems that would otherwise be developed independently. By doing this, we can avoid costly duplication while at the same time improve the quality of information available.

The RUIS work program is based partly on the logical relationships between the various application modules. For example, we can't complete the development tracking module until the building permit and land development modules are operational. But another factor was to schedule development to provide immediate functionality and to provide the City and County a big bang for their buck.

Lessons learned and some approaches which have worked or not worked for San Diego

We decided to approach the development of our GIS as a multidepartment, multijurisdictional project. Other cities and counties have taken a more departmentalized approach. Obviously, we feel that there are advantages to an integrated approach, but we also recognize some disadvantages. The major disadvantages of an integrated approach are:

1. It takes longer to develop. A single department can develop a limited-use GIS much more quickly.

2. It is more complicated. Large, multipurpose systems require more complex computers and software. San Diego County, with a population of 2.2 million, will be developing the largest municipal GIS that I am aware of. The computer hardware and software to meet our needs does not exist. As a result, we are working with IBM to develop a new system.

3. An integrated system requires considerable resources to administer and coordinate all of the different departments. In San Diego, we have three people to do this.

The advantages of an integrated approach seem to outweigh the disadvantages, at least in San Diego. The advantages, as we perceive them, are:

1. The system is less costly to develop. By sharing computer resources and data, an integrated system costs less to develop and maintain.
2. An integrated system allows for data sharing. This is the single most important advantage of an integrated approach.
3. An integrated approach allows for the entire data base to be updated through the day-to-day transactions involved in operating a municipal government.
4. An integrated approach seems to be a better long-term solution. Many jurisdictions which began with departmental GIS's are now trying to integrate them.
5. An integrated approach probably increases the value of the data and therefore its revenue generation potential.

Acquiring Management Support

Before you can get started with a GIS, you need to get support, especially financial support, from management. Here are some things we have learned about getting management support.

1. Find a project champion, someone who will stand behind you and the project. It should be an influential, upper-level supporter who can help convince other decision makers to buy into the project. It could be the city manager, mayor, county supervisor or department head. In San Diego, a member of the County Board of Supervisors was instrumental in the formation of RUIS. Now, both the San Diego City Manager and the County CAO are on the Policy and Budget Committee.
2. Effective communication is another essential ingredient to success. You need to get the message out in straightforward, visual form. The graphics associated with GIS are the most exciting element. Think about putting together a slide presentation or a video. If you don't have the resources, ask a vendor for assistance or get a video developed elsewhere. In San Diego, we have used slide presentations, a quarterly newsletter and progress reports.

   When communicating your ideas, especially in the formative stages of the project, it is important to focus on:

- The overall picture. Developing a GIS is a complicated project. Focus on the big picture, not the technical details of the computer system.
- The benefits of the system, not the technology. That is, how will the GIS help improve productivity, decision making and service delivery.
- The return on investment. Developing a GIS is costly. You must be able to justify the costs by documenting the improvements in efficiency and reduction in costs that the system will yield.

3. An appropriate organizational structure is also important to the success of the project. You need a structure to deal with policies, budgets and management decisions. You need a project administrator to deal with day-to-day management. Since the system will serve many different departments, you need a mechanism for bringing in departmental resources as they are needed, especially during system development. Finally, you need an effective way to manage the data processing resources which will be required.

   In setting up your organizational structure, some things to keep in mind are:

   o You need flexibility in management and decision making. A GIS represents new technology and many changes in how things are done. Decisions need to be made quickly, but the organization also must have the authority to carry out the decisions.

   o The organizational structure, at least during development, should be nonpolitical. Decisions about vendors and system design should be based on technical, not political criteria.

4. A stable or relatively certain funding base is needed because developing a GIS is a multi-year process. Concerns about the project being short circuited because of a lack of funding can jeopardize the success of the project.

5. Centralized management will be a big help. An integrated GIS will involve many different departments. There needs to be a centralized process for management and conflict resolution.

Information Requests: Emerging Issues

Once the system is in place and you have data available, the private sector will begin asking for access to the data. How to respond to these requests is an issue being dealt with by many jurisdictions. A this point, there are no clear-cut answers, but here are some of the issues you will have to deal with.

1. How will the data be delivered? Reports, tapes, diskettes, and on-line are some possibilities.

2. How do you provide data security? That is, how do you insure that on-line users don't consciously or unconsciously corrupt the data base or have access to confidential information?

3. How do you charge for the information? Some jurisdictions look at the GIS as a revenue generator, others feel obligated to provide information at no charge. This is a policy decision that should reflect the philosophy of the jurisdiction.

4. How do you market the data? Do you hire sales people or license private companies to sell the data?

5. What types of data and services do you sell? Do you package special products for sale?

6. How do you deal with public records laws, which require government agencies to provide free access to public records?

7. How do you insure confidentiality of data? How do you define what is confidential?

What can you expect from a GIS?

1. Expect to spend a lot of money developing the system and converting the cartographic data to computer form. In San Diego, we expect to spend about $16 million over a ten-year period.

2. Don't expect the system to be developed overnight. It will be a multi-year project.

3. This is a rapidly changing technology. You must make an effort to keep up to date.

4. The GIS industry is changing rapidly; new firms are entering the market and there is likely to be a shakeout of firms.

5. Once the system is in place, it should greatly assist with decision making. For the most part, GIS is a decision support system.

6. It will also help reduce redundancy in local government. This should improve staff productivity.

7. Finally, the GIS may lower costs. Many studies have shown that GIS's have benefit-cost ratios in the neighborhood of 3 to 1, to 5 to 1. In reality, however, these systems will create a demand for information that may affect the cost savings.

D. INTERORGANIZATIONAL COORDINATION IN COLORADO - PREFACE

Location is often a common demominator among many public and private sector groups and their missions. Organizations in all sectors are using improving GI technologies to manage their own information. Redundancy and expenditures are growing. Initiatives at all levels highlight the need and opportunity to coordinate GI development, and thereby, maximize investments while reducing redundancy. A 1987 study conducted by the Joint Nordic Project concluded that single departmental approaches generally have paybacks of 1:1; multidepartmental 2:1; and multiorganizational 4:1. Similar results and incentives are being concluded from other organizations, as revealed in the cooperative approach developed by the City and County of San Diego.

Local governments, including municipalities, counties, special districts and public utilities are especially fertile ground for cooperative projects, data sharing and joint development. Some innovative projects are emerging in various parts of the country, such as the joint municipality - county project in San Diego. A similar city-county effort is underway in Orlando and Orange County, Florida. Cooperative projects between municipalities and utilities also hold great potential for improved cost effectiveness as is being developed in Indianapolis, Indiana. A third form of interorganizational cooperation is between government and the private sector. Such opportunity is being developed in Ada County, Idaho and Adams County, Colorado.

Colorado has many excellent examples of interorganizational cooperation in general and in regard to GI coordination. These efforts can be a foundation for future initiatives.

D.1. METRO DENVER NETWORK: A FIRST IN METROPOLITAN COOPERATION

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Any promotional literature on metropolitan Denver will tell you that this region is unique for a number of outstanding reasons: its striking natural backdrop of Rocky Mountains rising to the west, a diverse and highly educated population, unparalleled recreational opportunities, and an area economy more balanced and dynamic than many realize.

In the increasingly competitive economic development climate that exists around the country among major metropolitan centers, however, the Denver area has a special, new "edge" that goes beyond its usual attributes. And so far - until this existing concept catches on and other communities realize what they're missing--no other metro area in the country can boast of such an edge.

This special attribute is the innovative Metro Denver Network, a cooperative organization compromised of virtually all economic related-entities in a six-county region.

What makes this Network unusual? For years, in communities across the nation, industrial development offices and chambers of commerce worked independently to promote their own jurisdictional areas and attract business and industry. Duplications of effort in an area were common, and sometimes neighboring entities even worked against each other--when regional economic growth would clearly benefit everyone.

For the cities and counties in the Denver area, those days of intra-area competition and wasted resources are gone forever.

The Metro Denver Network was founded in early 1987 based on the belief that the Denver area should be marketed nationally as one entity. Area public and private economic developers had already cooperated together informally, sharing resources and combining forces to target specific prospects, and the results had been positive. Why not a formal agreement to make Denver's message even stronger, more coherent, more responsive?

With the greater Denver Chamber of Commerce serving as a lead sponsor of the concept, a charter document was drawn up. "We, the undersigned, agree to form the Metro Denver Network, an organization that combines the resources of all metropolitan area economic development agencies for the purpose of attracting more new business and industry." The roster of original signators was an impressive collection--Colorado Governor Roy Romer, Denver Mayor Federico Pena, suburban mayors, county commissioners, and business leaders representing nearly 40 organizations. There is no other effort in the country where agencies representing six counties, 17 cities, nine chambers of commerce and a host of private and public sector groups have created such a formal organization.

"This Network is an important addition to our efforts to bring business and industry to Colorado," Romer said that day. "We must be strategic if we are to win the increasingly competitive economic battle, and this concept is both competitive and strategic. It is essential that business leaders work closely together to revitalize our economy. The Network is an excellent example of the kind of cooperation that must exist."

As a collaborative venture, the Network will actually provide two links among the metro area's economic development groups--one in the form of a sophisticated shared computer system and the other in terms of people. The computer data storage and retrieval system has been developed through the Colorado Alliance of Research Libraries (CARL). Using this system, agencies input and access data for prospects that had previously been conveyed via telephone or mail -- if at all.

One of the key benefits of the Network is that members will have consistent information to distribute. In the past, for example, two counties might receive identical requests from a prospect--but the research information might not be the same. Metro Denver did not always present a clear, concise picture to outsiders. But now, the inconsistencies and the accompanying redundancy of effort have been eliminated.

Each Network member now saves time and money, with precious resources of each staff devoted to industries in a specific area, helping them grow and expand. Advertising budgets are being trimmed, too, with each member helping to "sell Denver first" rather than trying to establish an identify for an individual county or city in a national campaign -- but with limited funds.

Not to be overlooked in the Network's benefits are the shared resources of "human hardware" as well. Beyond the high tech aspect of the Network is a spirit of cooperation that can't be measured. A new sense of trust is building between members, a willingness to work together toward a common goal.

Members of the Metro Denver Network include the following:

Adams County Economic Development, Inc.
Arvada Chamber of Commerce
Aurora Chamber of Commerce
Boulder Chamber of Commerce
Greater Brighton Area Chamber of Commerce
City of Brighton
Broomfield Economic Development Corporation
Castle Rock Chamber of Commerce
Centennial Chamber of Commerce
City of Commerce City
City and County of Denver Economic Development Agency
The Denver Partnership, Inc.
Douglas County Economic Development
ECO Aurora, Inc.
Economic Development Association of Longmont
City of Englewood
Golden Chamber of Commerce
Jefferson Economic Council
City of Lafayette
Lafayette Chamber of Commerce
Lakewood/South Jeffco Chamber of Commerce
City of Lakewood
City of Littleton
Louisville Chamber of Commerce
City of Thornton
Wheat Ridge Chamber of Commerce

Ex-Officio Members:
State of Colorado
Colorado Alliance of Research Libraries
Colorado Association of Commerce and Industry
Colorado Chapter of the National Association of Industrial & Office Parks
Denver Regional Council of Governments
Rocky Mountain Chapter of the International Association of Corporate Real Estate Executives
Public Service Company of Colorado

Real Estate Members:
Denver Board of Realtors
Coldwell Banker Commercial Brokerage
Cushman & Wakefield
Fuller & Company
Grubb & Ellis Commercial Brokerage
L. J. Hooker International
Iliff, Thorn & Company
Moore and Company Commercial
Frederick Ross Company
Van Schaack & Company

D.11. DENVER REGIONAL COUNCIL OF GOVERNMENTS

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I personnally feel that GI coordination could save significant amounts of money, avoid needless duplication, and result in better quality data.

Organization: Denver Regional Council of Governments (DRCOG). DRCOG is a voluntary organization of counties and municipalities within the eight-county Denver-Boulder region, performing such tasks as transportation development and water quality planning, population and employment estimates and forecasts, police and fire recruitment, and services to the elderly.

Current or Planned Use of GI: While DRCOG does not have a GIS system, we do deal extensively with geographic information. A regional Geographic Base File (GBF) is maintained and updated for use as an address coding file for assigning input records to such geographic units as counties, municipalities, census tracts, and transportation analysis zones. This file plays an integral role in the population, employment, and birth and death estimates that we produce for small areas.

DRCOG possesses microcomputer (Atlas*Graphics and MapEdit) and minicomputer (Calform) thematic mapping software, which produces analytical and publication quality maps of various economic and demographic data. Our collection of geographic linked data includes Census data and DRCOG estimates. Currently mappable geographic units include counties, census tracts, regional statistical areas, and municipalities. Recent acquisition of a Calcomp digitizing tablet should permit us to add new polygonal layers (such as transportation analysis zones and legislative districts) and a simplified roadway underlay.

Expected Benefits and Current Approach: It appears unlikely that we will acquire a GIS in the short term. Internally, we are exploring the potential uses of such a system and the associated costs and benefits. Our existing commitment to GI results in substantial savings in time and increased accuracy over a manual system.

Unique Approaches: Earlier this year, DRCOG worked with the Colorado Department of Local Affairs (CDLA) to produce a digitized file of current municipal boundaries for cities and towns in the Denver-Boulder region. This project involved our intern updating boundaries on the USGS County Map Series and then digitizing them at CDLA using an ARC/INFO system. A Digital Line Graph (DLG) file was then provided to us on diskette, which we then converted to a polygon format for use with Atlas*Graphics.

Joy Green of DRCOG has recently completed an informal survey of the major county, municipal, state, and utility GIS systems in the Denver-Boulder region. Millions have been and will be invested in such systems. There has been little if any coordination in system acquisition or base map creation. Indeed, it appears that a number of entities are engaged in the creation of duplicate regional detailed street networks. The ability of differing systems to easily exchange data was identified as another major issue. Information sharing on successes and problems with systems has been sporadic. Developers of a system in one jurisdiction have often been unaware of similar projects in neighboring areas. More complete results of the survey have been presented to DRCOG's Regional Planning Advisory Committee, which is composed of the chief planning officials of our member governments.

GI Coordination: GI coordination lets interested parties know what others are doing and have done. Costly mistakes may be avoided. Information exchange could be facilitated. The creation of a common base could be encouraged, thus avoiding duplicative efforts. Cost sharing in aerial photography and machine readable USGS Digital Line Graph Files could be facilitated. There are many opportunities in Colorado.

D.III. ADAMS COUNTY AND AT&T

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I would like to present a chronology and to show through the Adams County experience how emerging geographic information systems will interact with the overall County information structure. This paper will show how the concept was developed and how the project has been managed up to the current time. Beginning with Adams County's organizational challenges and goals, this addresses our current activities including the geo-information effort, the move toward a distributed environment, and ends with a description of the challenges we see for the future.

BACKGROUND

County Organization - Adams County is a political subdivision of the State of Colorado. It is one of sixty-three counties in this state and is approximately the fifth in population. Adams County is organized under the traditional commissioner form of government with three elected county commissioners presiding. The Clerk & Recorder, Assessor, Sheriff and Treasurer are separately elected officials, independent of the Commissioners except for funding purposes. A commissioner-appointed County Administrator oversees such departments as Management Information Services, Social Services, Personnel, Parks, Building & Planning, Highways, Finance, etc.

Growth issues - The growth issues are the new three billion dollar airport in central Adams County, the E470 beltway which bisects Adams County, and the Super Collider which if built in Colorado, will be located partly or wholly in Adams County.

Nature of MIS Problems - Adams County's constitutionally mandated organizational structure and the consequences of changing from a rural to a suburban County leads to a number of issues the Information Department must weigh in planning for the future.

- Available resources are being squeezed between an intensifying demand for County services and a legislative cap on our revenue.
- As a totality, Adams County's offices and departments are without central administrative direction and are geographically dispersed.
- County data is being perpetuated in application-specific data bases. Control of, and responsibility for information is disunited, and fragmented along departmental lines. This prevents the consolidation of information for a Countywide view of issues.
- The same information is captured in multiple administrative areas, from different sources, and by a variety of methods. Information thereby becomes adulterated, and at any given point in time the same information from different areas can have different values.
- Decisions are being made through all levels of our organization without sufficient or timely information being available.

A Bit of History - In 1985, the County's IBM SYSTEM/38 was experiencing a serious capacity shortfall. Many small and unrelated applications were consuming extensive amounts of processing capacity and storage. A backlog of applications requests was growing and this combined with the high maintenance required by the old programs, was beyond the capacity of the existing programming staff. The apparent solution was to hire more staff and either immediately upgrading the SYSTEM/38, converting to a larger mainframe, or migrating to a distributed environment.

Goals for the Information Initiative - In preparing a response to these challenges, our investigation identified the Information Department's long term goas as:

- Capture any piece of information once, at the first point of contact with the County, and have an intelligent group of cooperating computer applications control any related interdepartmental issues.
- Reduce or eliminate the cost of clerical staffing for the "back office" type of task throughout the County's departments and offices.
- Reduce or eliminate the requirement for citizens to have multiple transactions - one for each department/application. One contact with the County should be enough.

Multi use computer systems are more cost efficient and more effective in the delivery of County government services. There are many points in which information contacts the County and the number of single use applications with a high volume of transaction is a comparative few. Applications on central computers are typically highly structured and can be justified only when there is a high volume of transactions. We concluded therefore, that for our goals, the architecture of a centralized computer application was unsuitable. The following reflect the MIS department's plans for providing information systems support to Adams County:

1. Reduce or eliminate the backlog of new applications requests.

2. Develop with our users an awareness of the value of contywide sharing of information and applications.

3. Develop a nucleus of cooperating applications based on a distributed database that spans the entire county.

GEOPROCESSING INITIATIVE

It was the search for an appropriate nucleus of applications that led to the Geoprocessing initiative. We realized that around 80% of the data being currently captured by the County's departments was land-based. This provided fertile ground for meeting all objectives for demonstrating the value of Countywide sharing of information and applications. Therefore, in October of 1985, the MIS Department began an initiative to bring some level of intelligent, computerized mapping graphics and distributed database technology to the County. We had reviewed expensive vertically integrated automated mapping systems in other municipal/county settings; the usual development cost five million dollars and took five years. In 1985 there appeared to be no way to implement such a Land Information System within our budgetary constraints. A three phased approach was therefore, adopted in order to minimize the risk to the County while allowing us to locate any possibilities to complete this initiative:

1. Initiate a low risk technology investigation to determine if the various parts of the industry could support our plans at a cost we could afford. If this was unsuccessful we were only out our time and a small consultant fee.

2. Pursue a more substantial pilot involving the purchase of mapping workstations and training personnel. Establish a laboratory environment in which to develop and demonstrate the mechanics and benefits of a geo project. If this pilot failed to provide an acceptable implementation plan the hardware/software could be transferred to the mapping group in the Planning Department and we would only be out a larger consultant fee and more of our time.

3. Launch the major effort involving the conversion of the County's graphical data into digital form, purchasing of more workstations, communications equipment and writing the applications for the new environment.

My staff concluded that advancing technologies could provide cost-effective, high technology solutions to the problems of operating a county government with this fragmented authority structure and diminishing available resources. Despite the unresolved budget problem, this initiative was considered important enough that we were able to secure the approval of the Commissioners to commence Phase One.

Phase One

The MIS Department had no in-house expertise in geo-based issues; therefore, we initiated a search for a technical consultant. Our search ended when we retained Ed Fisher of Westin Engineering Corp., a reputable firm specializing in Automated Mappling/Facilities Management (AM/FM) and Geographic Information Systems (GIS) technologies. Westin was charged with assisting Adams county with a review of the technology to tell us if indeed we could integrate off the shelf micro-computer equipment and techniques into a viable County geo-relational information system.

The Westin findings indicated that appropriate super-microcomputer technology, high-speed, non-proprietary relational data base management systems (RDBMS's), enhanced networked communications, and powerful micro-based geo-software existed. This would allow us to develop a dual interface in which data could be retrieved, entered or altered either as the normal by-product of our regular business data processing or globally as a result of polygon processing using the graphical interface. Further study indicated that, using the micro-computer system, we could marry land based non-graphic information (currently on the IBM SYSTEM/38) with the graphics elements of the mapping model.

We concluded that perhaps we could secure government grant funding or locate a blue chip firm in the private sector to co-venture this initiative to our mutual benefit. Ed Fisher introduced us to AT&T's Digital Record Systems, a business unit within AT&T concentrating in utilities mapping and, coincidentally, seeking to move into the county government or municipality arena. A meeting was held where we discussed our plans for an integrated approach for a County information system. It was clear from the start that we shared the same vision and soon formed a public/private partnership to pioneer this advanced technology in a joint laboratory environment.

Phase Two

With County Commissioners' approval, a contract was entered into with AT&T's Digital Record Systems to assist in completing a pilot project demonstrating mapping combined with data processing. We are also jointly pursuing the practicability of a countywide fiber-optic voice and data network. We were joined by the AT&T ten geo-consultants, Bowne Management Systems and Proxima Corporation, to pursue the best methods of linking various components and technologies to arrive at this revolutionary solution to mapping information systems.

We are using nineteen layers of the digital maps from the new international airport site generously provided by Mayor Pena's Administration and overlaid onto USGS digital maps. Comprising the next statum is a four square mile segment of the Assessor's digitized property maps; underlaying this will be a corresponding raster-imaged aerial photograph of these properties. We will compare the Assessor's maps, property assessment records and building permits covering the same area to see if, for example, there are unauthorized buildings that are not being taxed. Time permitting, we will prototype a Treasurer's tax collection data processing system on the same relational database as is used by our mapping model. This demonstration for the Adams County's Board of Commissioners will complete our pilot project. Our timeline calls for this demonstration to occur this Fall.

Phase Three: The Emerging Plan

Our goals - Our goals for Adams County's Information Initiative are the automation of interdepartmental communication and to reduce the back office staff cost. Our goals are complex because it is the first one to be distributed and involves the immediate need for mapping graphics, the need to replace the obsolete IBM SYSTEM/38, and the need to establish with our departments the value of shared information. Future initiatives will be a great deal less complicated after we have clearly established the validity of this approach and provided the technological base of hardware and systems.

The Developing Plan - Because our goals are complex, the planning process must, by necessity, also be complex. No timeline has yet been established for implementing an initial plan; however, the following represents our current view of the county's geo-initiative. We will:

1. Use the United States Geological Survey (USGS) digital maps as the base layer to which all other maps will be registered and coordinated.

2. Develop a digital property layer as a diagrammatic representation for an official Tax Map containing the apparent property boundaries, a centroid for the parcel, the building footprint, and a numeric property identifier.

3. Develop a street centerline database with address ranges by conflating the DIME file with the USGS base map.

4. Develop a digital zoning map as a diagrammatic representation of an official zoning map containing the basic zoning boundaries, the apparent centroid, and required key identifiers.

5. Develop the necessary data base and applications programs to bulk load the property inventory from the IBM SYSTEM/38.

6. Develop the necessary data base and applications programs for property tax collections, building permit systems, zoning systems, and economic development.

The Data Issue - Data becomes information only when it is available, where needed and in an understandable form. The most expensive, time consuming and difficult part of this initiative is the conversion of the County's existing numerical, textual and graphical information into a common integrated data base environment.

Base Mapping Issue - Presently we have elected to use USGS digitized maps as the base map. Our emphasis is on plainmetrics such as property, soils, flood planes, contours, and zoning districts, assessment data, political districting and management information. By treating this project as a representative model of reality, we can skip or at least postpone photogrammetry until (and indeed if) it is truly needed for a specific application.

Multi-User Map Graphic Overlay Issue - The advantage of a system that maintains data at the detail level is that it allows many ways to view that data and is therefore multi-user. It is our intent to install an additional information layer only after all the users of that layer have been identified, their needs examined and there is ample cost justification. Because of the shared multi-user nature of the map layers there are also likely to be multi-maintainers, thereby reducing a major cost.

Integration of Information Issue - The justification of these systems is this ability to combine related files of information about the County from within and from outside the county by means of a common index. The County's ability to process the land records without being concerned about which department's system they are a part of. Further, we need the ability to retrieve all the information concerning an issue regardless of the representation - that is, as a map, a computer report or as a file of written reports. Information in support of the decision process must have the ability to be related by means as varied as the types of decisions they are to support.

Information Control Issue (Security) - This is the County's ability to provide open access to information without having to be concerned about possible misuse of the computer system or the information available from it. Integration of the Countywide data resource will provide new scope and depth of detail to the data available to the terminal user. This will require us to develop more sophisticated control measures to prevent waste or other possible abuse. In addition to the normal password protection of files of information, we will need to begin controlling access to countywide views of data (you can have all the data, however in small packets, -- i.e., the paper towel method).

The User Interface to Information Issue - This is an interface which is regular, uniform throughout the County's applications and is designed using a simple picture-based command structure so that an average person can understand it. Training cost will be reduced because it doesn't take as long to learn and because all of the department's applications will look the same. Documentation costs are thereby reduced and moving personnel between departments is facilitated.

The Public Access to Information Issue - County Government is the steward of a great deal of information about real property. The public has a right to expect speedy and convenient access to that information and the faster we can process each access the less it will cost the county. The interface will place no barriers between the utilization of graphical, textual, or numerical information nor will we depend on which department's application originated the data. In fact, we will combine these methods of presentation where indicated for maximum impact or effectiveness..

The Inter-Applications Communication Issue - A Countywide information base that uses point of contact updating and interfaces all data to any authorized user requires interconnection between all users. We are pursuing the practicability of the phased installation of fiber-optic cabled communications between the various County buildings. This system will use a central administrative control to provide a voice switching system as though we were all in the same building and will use only one group of operators. The data portion of this cabling system will provide us the ability to distribute the County's data geographically and still use it centrally by means of the dedicated, high speed inter-networks.

The Conversion and Education Issue - The process of changing first our application development methods and then the way the user's staff performs their duties will be difficult. Video tape allows departments t self pace their education independent of the availability of MIS personnel. Courses for the MIS staff have been purchased and we are reviewing the possibilities of producing in house high quality video courses for user personnel.

The Cooperating Partnership Issue - The development of the mapping issue depends upon the cooperation of a number of organizations. Whether the required work is performed by outside services, by consultant personnel working on site or by County personnel all activities will be under the overall direction of the County's project administrator.

The following list demonstrates the types of work products and the likely sources we will require:

Service company support procured under our normal purchasing policies for:
1. USGS digital map conversion (DLG)
2. DIME file conflation
3. Digitized parcel boundary map overlay
4. Aerial photograph of the county as a raster image
5. Ground control (GPS)
6. Parcel numerical data capture

Software customized by outside sources to Adams County's requirements to do the:
1. Vector mapping
2. Raster image processing
3. Network communications
4. Data base environment
5. Application's users interface

Adams County's internally developed applications programs for:
1. Building permit systems
2. Property tax collections
3. Zoning systems
4. Economic development
5. Political zoning
6. Property tax analysis
7. Building code enforcement
8. Planning

Cost Recovery - There are opportunities to collect royalties from the sale of any custom systems software which public funds are used to develop or aided in developing. We will collect royalties from the applications which we will be developing for the County's departments. ALso, there is the possibility of cost sharing with public or private organizations wishing to use this collection of applications and data. Lastly, we are pursuing grant funding for this innovative effort.

FUTURE DIRECTIONS

The Ground Control Issue - That is the physical boundary of an individual piece of property. Ambiguities in the legal description on the individual deed and inaccuracies in surveying make it unlikely that any property line in the County can be located within ten feet. These issues will remain regardless of the action we are taking to monument and to map. The county's responsibility, if any, for correcting this needs to be defined and assigned. The engineering of an adequate control network and a plan for monumentation were included in our project and several methods for correcting this were suggested:

1. Digitize a second property layer using the legal description from the deed as input to coordinate geometry (COGO) module. Compare this layer with the digital tax layer or the digitized aerial photographs in order to identify problems with the legal description.

2. Require the tract developers to provide digital COGO inputs to the planning department when requesting approval for their tracts. Therefore, our maps would become more accurate with time.

Continuing Geo-Project Development - Opportunities to continue development from our initial plan are almost limitless but the following list are some of the first issues that come to mind:

1. Develop an interface with the video disk technology so that document files can be retrieved directly using the map as an index.

2. Provide our mapping system, data and application software to the Adams County cities and perhaps at some level to the school districts.

3. Develop the process for updating the map and the Assessor's files as an automatic by-product of the building permit process.

4. Conflate data files from outside the County, such as the census information, the nine digit zip-code, Dun's, or any other digital tapes with our system's address file.

5. Develop a computer-assisted political redistricting system using the graphical interface.

6. Develop the unofficial tax and zoning maps into the official Adams COunty Tax Map and the Official Zoning Map.

The continued development of micro-computer software - Further development concerns the ease with which we can integrate the processing of information in different forms. Adobe's PostScript is rapidly becoming an industry standard method of storing graphical objects. SUN's object-oriented enhancements to PostScript (driving both screens, printers and plotters) extend the standard to include network sharable graphical objects It is our opinion that a method can be developed to store maps and their associated textual data through these methods. This gives us the ability to use maps which can be annotated, pasted into reports, or incorporated into presentation graphics.

Government Planning and Control Systems - This is the recording in detail of every unit of work performed by the county combined with any labor and/or material used to accomplish that work. Manufacturing plants use this type of system which they refer to as manufacturing resource planning systems (MRP), as their basic information resource. By relating the detail cost in various ways they support their important strategic decisions such as pricing, capital planning, and labor requirements planning. Accounting, labor distribution, sales orders, engineering drawings, production control, work orders in process, purchasing, and quality assurance are all blended into a single enterprise-wide communicating information system. Information is commonly captured at the point of contract through the use of "Bar Codes" similar in appearance to those found on the products purchased from a super market. Implementing such a system would provide the County's elected officials and the general public with a factual basis for judging the appropriateness of public spending. Further the County's staff would use the information for operational planning, direct verses indirect cost analysis and as a basis for the allocation of resources. This system would be a first as no county known has successfully implemented these techniques, at this level of detail, due to problems with available technology and cost. Because of the above reasons this initiative was delayed until after the geo-relational information systems demonstrated the value of shared, distributed information, and provide a basic foundation of equipment and software.

Criminal Justice Information Systems - The necessary cooperation or political support for this broad category of systems is lacking at this time. Indeed, even the more restricted Adams County Sheriff applications *bookings, jail management, uniform crime reporting, etc.) are to be developed elsewhere as a result of our fragmented authority structure. If the required cooperation could be achieved between the Police agencies, the Seventeenth Judicial District, the Colorado State Court system, and the Adams County District Attorney there is an opportunity for significant clerical improvement, more secure offender tracking through the justice system and for a more uniform and efficient scheduling of court attendances.

Social Services - The State of Colorado Social Services Departments have a divided authority structure. This is by design and is believed by our legislature necessary in order to preserve the independence of the social worker. The State provides the programs and the standards and the County supervises the delivery of services and the employees. This area has great potential for the improvement of service through the use of techniques such as "point of contact" systems and the "expert systems" approach to improve clerical efficiency, for the selection of the most appropriate social services programs, and for fraud detection. There are clear opportunities to reduce per-case costs considerably. Due to the lack of any clear mandate at this time, no current plans exist for any County information systems effort in this area.

D.V. METROPOLITAN STATE COLLEGE AND ...

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There is an obvious need to inventory Colorado's existing Geographic Information Resources and Systems. Metropolitan State College, through the Office of Institutional Research and along with the departments of Computer and Management Science and Earth Sciences, has volunteered to undertake the first step in the inventory process.

With the aid of several Federal and State agencies acting as advisors to the project, we have developed a questionnaire to ascertain the existing digital geographic information systems now available within our state. I believe this is a good working example of interorganiational coordination and cooperation, and all of you attending this forum will have the aopportunity to participate in this effort.

You have received a copy of the survey in your program packet. Please complete the questionnaire and return it, along with your evaluation of the program, at the end of today's forum, or mail it to the Office of Institutional Research at Metropolitan State College.

I would like to introduce and thank the following individuals associated with Metropolitan State that have put a great deal of time and effort into this project: Dr. Judy Barlow of the Department of Computer and Management Science and the following students, Greg Mally, Scott Elder, Mike Zavori, Mike White, Donna King, and Jim Holland.

D.VI. COLORADO'S OPPORTUNITIES IN GEOGRAPHIC INFORMATION

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Economic opportunity and natural resource management are two areas where better use of geographic information (GI) and geographic information systems (GIS) can reap tremendous benefits for Colorado. GI systems are capable of inductive leaps. Opportunities can be discovered which we did not realize existed by the use of these technologies. This is a key for economic opportunity and development in Colorado.

As an example, it took a midwestern company to identify a prime industrial site on the Front Range which local and state planners had missed. The site of the nearly complete Anhesuer-Busch Brewery was not contained in any of Fort Collins area growth documents. We had a blind spot for an industrial site which contained a rail line and access to an interstate, which were major criteria for a brewery site. We had used too fine of a planning resolution.

We need to decide from what altitude to focus our GI systems. What should our scanning resolution be? Besides a local perspective, I believe we need a coordinated regional or state view. Systems are needed which can remember and tend to be more unbias.

Another example is that many studies have been conducted on the water resource potential of the Cache La Poudre River. Taxpayers dollars have been paid to consultants again and again to learn about issues, problems, and opportunities in the Poudre Basin without the development of a comprehensive way or system to capture the information gained. Many maps have been colored and tables developed. However, additional questions policy-makers may pose will be costly to answer because the information is not in a form for easy use. A GIS might enable the region and the state to build on each piece of new information to develop a more efficient water resource system.

Citizens, media, and decisionmakers are ready for interactive, video screen technologies. In Colorado many GI systems have been developed. We in Colorado need to coordinate, be open-minded, and be ready for the opportunities that GI technologies can provide us whether in economic opportunity or natural resource management.

SECTOR PANELS: USES AND PERSPECTIVES - PREFACE

Geographic information development is emerging in many sectors both in and outside Colorado. Six main groups or sectors can be identified. The four panels presented during the afternoon portion of the Forum testify to increasing levels of activity in the business community, local governments and state and federal agencies in Colorado. Related initiatives are also occuring in the state's academic community and professional associations. In addition, as GI is developed by all sectors, appropriate roles and responsibilities for each can be identified and agreed upon. Inventorying and development of activities in each of these six sectors would help support a broad GI coordination initiative in Colorado.

Colorado's academic institutions have a national reputation for many programs, including environmental, computer, and engineering sciences. These disciplines are utilizing and teaching various GI technologies and potentially can assist the state in many capacities. At the national level, some of the country's strongest academic institutions in GI, are vying for selection as the National Science Foundation's designated Center for GI and Analysis. Though a Colorado proposal will not exist for this center, proposals are being prepared from Colorado institutions for selection as one of the nation's Science and Technology centers to build upon existing programs. An initial inventory of persons involved in GI technologies at Colorado's academic institutions was conducted to create a mailing list for the Forum. A review of research programs, facilities and curriculum would help provide an educational foundation for both public and private organizations and help identify and market Colorado's strength in the GI industry.

Colorado has many strong professional associations, with some serving as headquarters for national or Rocky Mountain area organizations. For example, the headquarters of Automated Mapping/Facilities Management International, with 1200 members, is located in Englewood. Their annual conference, regularly held at Snowmass, is one of the largest in the state. Three strong local chapters, of the Urban and Regional Information Systems Association (URISA), American Society for Photogrammetry and Remote Sensing (ASPRS), and the American Congress on Surveying and Mapping (ACSM) also exist. They helped support the Forum by providing refreshments during the breaks. Colorado Counties, Inc. sponsored a survey of county GI activities during 1987 and others are developing education programs. At the national level, associations have sponsored numerous conferences and meetings with some aspect of GI technologies on their agendas. Association memberships and attendance at these sessions are increasing markedly in recent years. A national association of related associations, is emerging under the auspicies of the Institute for Land Information (ILI). It includes over 25 member associations, including functionally specific groups such as the American Bar Association and American Society of Civil Engineers. A similar local group might help develop jointly sponsored educational programs, forums and networks.

Activities described in each of the four panels, as well as activities in he academic community and within the professional associations, represent a valuable foundation and resource for Colorado.

E. BUSINESS COMMUNITY - PREFACE

A community of geographic information businesses is emerging throughout the nation and world, and many have or are locating in Colorado. Evidence of this "GI industry" is growing daily. Many companies like governments, use GI to better operate and manage their businesses. For example, Pizza Hut and Federal Express use digital maps to quickly serve their customers.

Many new companies are forming to provide or convert data in a digital form, serve as service bureaus and consultants for public agencies. Large, traditional data processing companies and utilities are also joining this industry as governments are identified as needing improved technologies. A 1986 market research study conducted by Automation, Inc. concluded that "local governments and utilities will spend up to $90 billion between now and the year 2000 on information systems for the effective management of the nation's infrastructure". IBM found in a survey of its municipal customers that GI management is one of the top priorities of cities in the nation, ranking second only to infrastructure management. AT&T and others are funding pilot projects throughout the country.

Many early innovators in GI technology exist in Colorado, such as Public Service Company and various federal and state agencies. In addition, a regional Federal Center and many national technical headquarters are located here. These activities, and the major importance of natural resources to our state and our central location in the country, have led to Colorado being an informal center of the GI industry in the nation. It has been stated that Colorado has a greater concentration of activity than any other location in the country. Colorado can capitalize and build upon this strength. Initial documentation has been compiled by Bob Alexander of USGS and Dave Watts of Wild Hurbrugg Systems. This 1987 inventory found over 2,500 employees in GI in Colorado, including system vendors, conversion services, service centers, photogrametry, surveyors, engineers, consultants and energy information companies. These companies represent an annual payroll of over $10 million and some have national or even international clients.

The Forum's business community panel represents a sample of GI user companies in Colorado. Each uses it to better manage and operate their business, and does or can offer service or information to government. The panelists stated they could benefit and would join together in a private industry GI council to help educate users about GI technologies. Such a unified effort would increase credibility and help create demand. A council, and perhaps a group with nonprofit status, could document the GI industry, publicize successes, establish business networks, create models, identify market nitches and incubate new businesses. Capital and donations could also be generated for educational programs and facilities, perhaps in cooperation with the state's academic institutions. Modenator Sue Morgan, Deputy Director of the Colorado Advanced Technology Institute, questioned the panel about the appropriate roles of the public and private sectors. The concensus was that government should set standards and develop baseline information. The state should also take a coordination role to serve as a clearinghouse and facilitation of GI development. A suggested private role was to educate users, and provide modern, user friendly GI technologies that can be integrated and applied to various applications.

E.I. PETROLEUM INFORMATION

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PI provides historical and current well and production data to the oil and gas industry. Data is provided in multi-media formats; hard copy, microform, on-line, and digitally on tape and floppy disks.

In 1980 we initiated the building of a digital base map system for the U.S. (DEMS). This base file contains land grid and select culture features derived form USGS 7 1/2 Quadrangle Sheets.

We currently have over 850,000 square miles of digital data in our base file, in oil and gas provinces throughout the U.S. The state of Colorado is virtually complete.

We utilize a technique where a USGS quad sheet is scanned and data elements are digitized directly from a screen. Digitized elements are identified, providing layered extraction from the file. Separate layers can be used as needed, such as the land grid with or without roads, rivers, etc.

By combining the use of the DEMS file and our digital well data file which contains latitude - longitude location data, we provide our clients the ability to produce hard copy maps with well locations.

The Colorado Department of Highways has purchased our base file. This file has land grid (Sec-Twnshp-Rng), political boundaries, state, county, and metropolitan, national parks and forests, Indian lands. It also contains primary and secondary drainage, and major transportation (highways and railroad). The file also contains header data for each quad, showing date of issue and date of digitization.

Utilization of data by our clients is varied and expanding. We have recently installed Autotrol and ArcInfo to assist us in developing new applications.

We build as we perceive a need. Most of our digital map coverage has been underwritten by the oil and gas community. We have a unique form in developing all of our data bases in that we initiated a "Users Group" made up of clients. These groups provide us with advisory input into additions to files and or expansion opportunities.

Colorado is unique in that the Geographic Information for the state is centralized and can assist all state agencies with a need for this type of data. This is not true among other states, where each agency acts independently.

E.II. HARRISON RESOURCE CORPORATION

Mr. Craig Harrison
President
Harrison Resource Corporation
Suite A200
760 Whalers Way
Fort Collins, CO 80525
226-4100

1) Harrison Resource Corporation is a brokerage firm specializing in water and land resources along the Front Range.

2) Harrison Resource Corporation has a 3-dimensional, multicolored Map/Model of the northeastern Front Range, which bounds Stapleton to north of Fort Collins, and the Foothills to east of Greeley. The 1:50,000 scale model is extremely accurate, and is naturally colored to show different land uses such as: irrigated farms, drylands, forests, waterways, etc. Topographic features such as hills, valleys, ridges, and mountains are also accentuated. When the project is fully completed, the map/model will be 20 feet in length, encompassing Fort Collins to Pueblo; and be 5 feet in width, from Boulder east to Aurora. The model is further enhanced by a series of mylars on various topics, some of which include: utilities, water data, growth data, barriers to growth, land ownership, ditch systems, water ownership, demographics, and transportation.

3) Harrison Resource uses this tool as a planning center in which clients are able to make decisions based on the overall picture, rather than trying to look at individual locations, one at a time. By spending the time looking at the larger areas, it is possible to pinpoint specific areas of interest, eliminating unacceptable or unprofitable properties, before any driving starts.

4) Harrison Resource Corporation has developed its system on its own, at its own expense. We have found it is worth our investment and we are expanding this information resource.

5) The following may be of help in assembling the state's GI system.

   1. Make it graphical. A picture is worth a thousand words. Show the maximum area possible, because it allows an overall view.

   2. Use the KISS theory. Keep it short and simple. A possible solution is to create two information system: one for the gathering of data, which could be complex and used by different professionals; and one system which could be developed for use by the general public.

6) Growth, development and economic planning could be substantially enhanced with the use of such a graphic presentation, not only to government planning agencies, but to private entities looking toward relocation or growth in Colorado.

E.III. HDR INFRASTRUCTURE, INC.

Mr. Jack Miller
Vice President
HDR Infrastructure, Inc.
1100 Capitol Life Center
Denver, CO 80203
861-1300

HDR's GIS was developed in 1985 to provide a geo-data base for the planning of the new Denver airport. The system is based on ARC/INFO, a relational database. It is integrated with MOSS, a surface modeling software, which performs volumetric analyses and provides perspectives, and GDS. The hardware consists of two Micro/VAX II's.

The systems development took longer than anticipated for tried and true software. The system has over 20 layers of data and was originally developed for planning purposes to provide uniform information on topography, hydrography, land use, transportation, public land surveys, utilities, ownership, demographics, soils and contamination. During the planning process, additional layers resulted from input by various consultants, i.e., airfield configurations from an Intergraph program, noise contours and environmental factors.

The system has the ability to provide specific information needed by the City and its consultants in the desired format. Nearly 300 square miles were included in the data base for site selection. Once the general site was known, a master plan study area of 86 square miles was established for a more detailed data base.

Slides of data in a layer in different presentations of the data were shown. Also layers or parts thereof were shown in several combinations. The exhibits also demonstrated these uses of the data layers.

Our experience indicates the value of GIS lies in:

1. The uniformity and accuracy of data for all parties involved

2. The ability to tailor the information to specific needs

3. Tremendous analytical power of system for use in decision making

4. Economy in providing these advantages

E.IV. UTILITY NOTIFICATION CENTER OF COLORADO

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President
Utility Notification Center of Colorado
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Denver, CO 80201
572-4125

UNCC is a Non-Profit Corporation, funded 100% by its members.

The Center provides a central location for contractors and the public to call toll free when requesting location information of utilities including water, wastewater, gas, electric and telephone lines.

New Office at 9101 Pearl Street; 1-800-922-1987
530-6700 - Denver

We presently have 30 General Members and 3 Sustaining Members. Both utilities and municipals have joined the center for the primary purpose of protecting their facilities and promoting public safety.

Opened for business in May of this year and were overwhelmed with calls. We have added additional communication equipment and operators to handle the call volume. In August the Center took 8,400 incoming calls which produced 36,000 messages to its members.

The Center was started over two years ago when the first discussion of the need for a state-wide system took place. Since then we have spent our time developing the standards for Colorado One Call System, bidding and selecting a contractor to operate the system for us.

Our data base is driven on a section, township and range basis with a corresponding cross street reference overlay. At present for Denver a street addressable index system is used.

One of the biggest problems we have had in developing our data base was the lack of standardized reliable mapping information.

Additionally, educating the public in the type of information that is needed has had significant impact on the efficiency of the Center.

UTILITY NOTIFICATION CENTER OF COLORADO

GENERAL MEMBERS

1. Town of Meeker/Water Distribution
2. City of Brighton/Municipality
3. City of Colorado Springs/Municipality
4. Panhandle Eastern Pipe Line Company/Gas Transmission
5. Greeley Gas Company/Gas Distribution
6. Western Gas Supply Company/Gas Transmission
7. Macey & Mershon Oil, Inc./Gas Transmission
8. Colorado Interstate Gas Company/Gas Transmission
9. White River Electric Association, Inc./Electric Cooperative
10. Union Rural Electric Association, Inc./Electric Cooperative
11. City of Loveland/Municipality
12. Scripps Howard Cable Company/Cable Television
13. Columbine Cablevision/Cable Television
14. City of Fort Collins/Municipality
15. Public Service Company of Colorado/Electric Distribution
16. Coors Energy Company/Gas Transmission
17. Amoco Pipeline Company/Liquids Pipeline
18. Intermountain Rural Electric Association/Electric Cooperativw
19. Mountain States Telephone and Telegraph Company/Communications
20. Natural Gas Pipeline Company/Gas Transmission
21. United Cable Television of Colorado, Inc./Cable Television
22. Greeley Cablevision/Cable Television
23. American Cablevision/Cable Television
24. Jones Intercable, Inc./Cable Television
25. City of Brush/Water-Sewage
26. Mile Hi Cablevision/Cable Television
27. U.S. Sprint Communications Company/Communications
28. Conoco Pipeline Company/Liquids Pipeline
29. Phillips Pipe Line Company/Liquids Pipeline
30. American Telephone and Telegraph Company/Communications

SUSTAINING MEMBERS

1. Northwest Pipeline Corporation/Gas Transmission
2. Urban Drainage and Flood Control District/Water Distribution
3. Texaco Pipeline Inc./Liquids Pipeline

10/1/87

E.VI. MARTIN MARIETTA CORPORATION

Lee Aguiar
GIS Manager
Martin Marietta
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977-3000

Martin Marietta Corporation specializes in requirements analysis, design, development, and integration of automated systems. For more than a quarter of a century, the corporation has been involved in producing hardware and software for major space and launch vehicle programs, as well as defense programs, and in integrating that hardware and software so that they work as a total system.

Martin Marietta is diversified in the technologies that are essential to solving major systems problems, and has developed and honed those technologies in traditional aerospace and defense pursuits. Now it is applying them to the production of tomorrow's information and communications systems. Martin Marietta Information & Communications Systems (I&CS) was formed in 1984 to focus the Corporation's resources and expertise on the rapidly growing information processing and communications fields. The company is experienced in an array of associated activities that fall into the information and communications systems area.

Some of our interests are in the area of developing integrated Geographic Information Systems (GIS) for use by end users. Our current use of GI is for electronic maps, terrain analyses and robotic vehicles. The electronic maps are managed and manipulated using a raster-based record management system. The terrain analysis and robotic vehicle applications are both accomplished using a commercially available GIS and our application specific software. Automated real-time applications would not be possible without geographic information and GIS. Manually generated analysis which took two weeks to produce is now able to be done in two hours. Additionally, analysis can be easily done in greater detail and GI systems can quickly respond to unanticipated requests for information.

Our policy is to continue to advance the state of the art in managing and using geographic information. We are also looking at joint marketing agreements with other GIS-oriented companies and thus offering our customers much needed capabilities now. Our direction of maintaining a state of the art capability using the correct commercially available hardware and software gives our customers the ability to analyze GI data in a timely fashion. Colorado needs to analyze their needs and available GI data to determine which GIS best suits the job. A system which would allow sharing of information data bases and allow easy incorporation of new and existing data could be of benefit to a large range of potential users. City and state planning, airport noise contours, crime statistics, fire-fighting aids, taxation and terrain analyses are just a few of the many applications GIS can be applied.

E.VII. PUBLIC SERVICE COMPANY

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Information Systems Division
Public Service Company
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PSCo is an investor-owned gas, electric and steam utility company. It has 6,000 employees and a service territory of 9,300 square miles (10,000 maps) with 950,000 electric customers and 840,000 gas customers.
Four of Fourteen operating divisions have been converted to our Distributed Facilities Information System (DFIS) since 1983:

- 235,200 electric customers converted (24.6%)
- 216,000 gas customers converted (26.4%)
- Approximately 2,800 out of 10,000 maps

Our scheduled completion of service territory conversion May 1991.

History of Project

1967-1972 original pilot project implemented (CINS - Command Identification Numbering System -- referring to State Plane Coordinates)
Cheyenne Division was only one converted.
1972-1977 -- PSCO participated in joint development of hardware and software with IBM.
1978 -- Economic Justification (First ever for DFIS application).
1978-1981 -- Review industry status. Although project deemed feasible, went on "hold" status pending development of new hardware/software offerings from vendors.
1981 -- Economic Justification reviewed.
$26M cost: $62M benefit over fifteen year period.
NOTE: This justification assumes Data Base or Facilities Management, not just Automated Mapping.
1981-1983 -- Development In-hours of GPG and GDBS applications.
1983 -- Conversion of Cheyenne DIvision (CINS) Database to new IBM format (ISAM to VSAM/LD/I).
1986 -- Second "Pilot" Project -- conversion of the Boulder Division"
540 sq. miles
690 1"=100' Orthophotos
170 1"=400' Orthophotos
72,000 Electric Customers
73,000 Gas Customers.
1987 -- Economic Justification reviewed.
$33M Cost: $78M benefit over fifteen year period.
1986 Onward -- Ongoing Conversion -- Northwest and Northeast Metropolitan Divisions. Ongoing refinement of conversion and field check procedures. Ongoing enhancement of conversion and database maintenance software, and of ties to other in-house, computerized systems (including CIS, EDF, NMS).

Existing Applications

Automated Mapping

DIF Software supports both interactive and batch plotting (the latter to designated remote devices).

CalComp plotting software supported.

Other ISPC (Industry Standard Plotting Command) Plotting applications software should be compatible.

Work Order Processing

Central Drafting inputs new land data from Contractor's Site Plan.

Engineering retrieves land data and creates proposed electric/gas facilities design at workstation. Plots design and issues construction work order.

Construction crew notes changes to design as required in the field.

Construction returns design plot, with as-built modifications to engineer.

Engineer updates proposed design to reflect as-built construction at workstation. Sends batch job to post new facilities to DFIS databases.

Conversion Software

Facilities ongoing conversion of existing facilities maps and other manual records.

Applications Currently in Development

Water and waste water systems

Metes and bounds (for entry of data according to legal description).

Polygons (Tax Districts, Zoning Districts, Fire Districts, Political Subdivisions, Parcel Ownership, etc.)

Applications Planned

1988-1990

Automatic Generation of Materials List
Automatic Generation of Materials/Cost Estimate
Transformer Load Management System
Tie to CADPAD (Electric network Analysis)
Tie to Stoner (Gas Network Analysis)
Property Accounting "Plant in Place Change" Data
Tie to Automated Warehouse (MDC)
Capacitor Location Analysis
Leak Survey Analysis
Automatic Generation of Macro Assembly Units
Automated Job Status Tracking
Attachment Billing Reports
Probable "Device Out" Analysis
Service Restortion Tracking
Meter Route Refolio
Meter Route Analysis
Structural Analysis Batch Programs
Connectivity Analysis Batch Programs
Cathodic Protection Inspection Scheduling
Main Renewal System

Products/Services Available

- Time Sharing and Machine-readable data
- Consulting
- Production of Field Check Maps
- Software Sale/Lease
- Software Installation
- Software Customization
- Client Training and Support
- Economic Justifications
- Photography
- Diapositives
- Blue-Line Reproductions of Photography
- Sepia Reproductions of Photography
- Black-line Mylar Reproductions of Photography
- Data Conversion to DLG (Digital Line Graph) Format

Previous Sales

- Gainesville Regional Utilities
  - Software Installation
  - Software Customization
  - Software Enhancements
  - 1 Sq. Mile Test Data
  - Customer Training and Support
- United Teleplex Corporation
  - Timeshare Hardware and Software
  - Customer Training and Support
- Boulder County
  - Converted PSCO Land Data to DLG (Digital Line Graph) Format for "ESRI" System ("ARC/INFO")
- City of Boulder
  - Orthographic Mapping and Aerial Photography
- County of Boulder
  - Orthographic Mapping and Aerial Photography
- City of Longmont
  - Orthographic Mapping and Aerial Photography

Accuracy of Photography

- Scharf & Associates - Flight Contractor.
- ITEK - Ground Control.
- Analytical Surveys, inc. - Analyzes Ground Control.
- Photoscience, Inc. - Produces Aerial Photos.
- 1"=100' MAPS flown at 600' altitude.
- 1"=400' MAPS flown at 1800' altitude.
- 90% of electric points used for aerial triangulation must be within one foot of actual location in real world.
- 1"=100' Photography accurate within 2.5 feet.
- 1"=400' Photography accurate within 10.0 feet.

Future Direction

- Testing IBM 9370 Distributed Processor.
- Development of Local and National Marketing Strategy.
- Increase in Staff to Complete Applications in 24 months.

F. LOCAL GOVERNMENTS - PREFACE

Local governments maintain greater quantities of GI and at a higher degree of accuracy than any other level of government. There are approximately 80,000 units of local government in this country, and 1,856 in Colorado, as of July 1987. They include 63 counties, 268 municipalities, 177 school districts and 1,348 special districts. Each one generates, collects and analyses one or more forms of GI.

Counties traditionally manage the greatest amount of land information at the parcel level, but usually in separate departments often managed by different elected officials. Mapping responsibilities are often located in differing departments often managed by different elected officials. Municipalities provide most services to the public such as utilities and public safety, and direct and regulate land development, but they rely on counties to manage land information bases for many needs. Special districts provide services such as schools, fire protection, water, sanitation, parks and recreation, pest control, and others, and exist for specific geographic areas. Regional associations of governments and nonprofit utility notification centers are emerging to also develop and manage GI.

There is increasing potential and evidence of redundancy and data in compatibility, especially as the number of special districts is increasing in Colorado. Counties and municipalities also sometimes experience internal redundancy in the development of reference information for the different functions. Colorado's local governments have differing legal directives, organizational structures, and lead entities applying to the management and development of GI. While each unit of government has unique needs, some standards would increase the value of local information for state wide purposes. Some state standards apply, but are sometimes not up to date or enforced.

As noted in various market analyses such as those stated in the preface to the business community panel, GI and infrastructure management are, and will be experiencing increasing levels of automation. Many of these developments are being instituted in or led by single departments, while other governments are adopting multidepartmental approaches. A recent trend is multiorganizational initiatives where governments are working together to maximize investments and jointly develop their GI resources. One of the most noted national examples of intergovernmental cooperation is the Regional Urban Information System being developed by both the City and County of San Diego, as explained to the Forum by its Administrator, William Bamburger.

While Colorado does not have any multiorganizational GI development initiatives, many GI automation projects are emerging in Colorado's local governments as explained by the panelists. A 1987 survey conducted in Colorado's counties indentified 10 related automation initiatives. The Colorado Division of Property Taxation is conducting a survey of mapping methods in County Assessor's Offices. The Denver Regional Council of Governments identified GIS initiatives in their region in August 1987. The results of these surveys of Colorado's counties are presented in Table IV.

A more thorough review of the counties from an institutional perspective, and a similar review of the municipalities and utilities, would be useful to identify activities, opportunities and educational needs as well as to share information and expenses.

Most municipal initiatives in Colorado are housed or lead by public works, engineering or utilities functions, as explained by panelists representing Colorado Springs, Longmont, Fort Collins, and Denver. Counties such as Mesa and Adams are initiating multidepartmental approaches, while others such as Boulder and Jefferson are being developed within the planning function. As revealed by the speakers, each government's approach differs based on individual needs, financial capabilities, authorizing environment and leadership.

When asked about the appropriate role of the state, the panelists stated that state government should serve as a clearinghouse and facilitator of GI development and create an information exchange network. The Forum served as an excellent first step to meet this need. It was suggested, however, that state government and agencies should be more coordinated before branching out to other governments and organizations. Once some improvements have been made, then legislative reform initiatives can be proposed and adopted. Another important role for state government is to create a geographic and geodetic reference base for the state. As concluded by moderator Marlene Fish, State Representative from House District 23, a state GI coordination project is competing with prisons and the homeless for scarce resources, and must be tied to economic development to be successful.

F.1. CITY OF COLORADO SPRINGS - UTILITIES

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City of Colorado Springs Utilities
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636-5663

The Colorado Springs Department of Utilities (CSDU) provides Electric, Gas, Water and Wastewater services to the City of Colorado Springs. Electric and Gas service areas extend beyond the City limits.

CSDU has been following automated mapping and facilities management (AM/FM) technology for several years. In 1986 CSDU, through IBM's application transfer methodology (ATS), completed a high-level feasibility study of its AM/FM requirements. The study reaffirmed the need for a system, outlined the overall costs and benefits of a system, and provided a general framework for implementation of an AM/FM system.

Subsequently, the Department of Utilities has been designated as the lead department for implementation of a system for the City of Colorado Springs. In August of 1987, CSDU began working with an AM/FM planning consultant.

Current activities include completing documentation of current systems and future requirements, and developing a detailed implementation plan. CSDU expects to make considerable progress in 1988 towards the implementation of an AM/FM system.

F.11. CITY OF LONGMONT - ENGINEERING

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The City of Longmont is just beginning to implement its Geographic Information System, and the final form still remains to be seen. We have, after about three years' study and hand-wringing, just selected and purchased our hardware, and are still in the planning stages of data entry, much less full system implementation. At present, participation in the City GI system is limited to our Electric, Water and Wastewater utilities, Municipal Engineering, and to a lesser extent, Planning. This is because our system was originally conceived as an automated mapping system to help us keep our City maps current during periods of fast growth.

As a mapping tool, we expect our system to earn its keep by allowing our drafting staffs to keep up with changes in the city limits and with the addition of new streets and utility lines. In the past, our maps were sometimes as much as a full year out of date just because we lacked the staff time to keep them current. This is not only an annoyance but an embarrassment, and by raising serious questions about City liability. An example would be if someone were injured by digging up a buried electric cable that did not show on any utility maps. We hope to be able to keep all maps of all types up to date in the future with a minimum of staff time by incorporating them into our GI system.

Although little planning has been done to date concerning additional uses of our GI system and its database capabilities, we expect other functional units of the City of Longmont to become interested in its possibilities once we are on-line. The Planning Division has shown the most interest to date, and the Planning staff has had some input into the process. Through them, we have begun a cooperative effort with Boulder County to share some tasks and avoid a duplication of efforts, as well as to ensure the compatibility of our databases.

Under our unofficial agreement, the City of Longmont has agreed to establish a network of high-precision surveying monuments throughout the Longmont area, if the County will begin its land data entry in the Longmont area. We have therefore, begun monumenting and locating a total of about forty section corners blanketing the present City Limits and extending out into our path of fastest growth. Nine of these points will be precisely located using the Global Positioning System, or satellite surveying. Coordinates on the remaining corner monuments will be obtained through conventional surveying means. By using this method, we hope to be able to attain an absolute accuracy of less than one inch in locating land parcels.

The City presently has no policy, formal or informal, towards a Geographic Information System. No funding mechanism presently exists, except for the commitment of staff time for data entry, and the operating budgets of the departments involved. The initial purchase of hardware was made possible through a loan from the Electric Utility Fund; however, this will have to be repaid and future purchases made through the normal budgeting process. The level of future commitment by the City to this technology probably will depend on the level of success we experience in this initial endeavor.

F.111. CITY OF FORT COLLINS - WATER DEPARTMENT

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Engineering Manager
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The many benefits of computer mapping are discussed more frequently than are the costs to change or the avenues to convert to computer mapping. Consequently, most of my comments will be addressed toward these sometimes overlooked issues.

As an introduction, Fort Collins is entering computer mapping and this process is being driven by the Utilities' need for accurate/timely mapping. Two types of base maps are being prepared. The first is a land base map with lots, subdivisions, addresses, parcel numbers and certain survey data. The second base is prepared using aerial photos and contains, among other things, roads, sidewalks, houses, driveways, and fences. Many other data will be added to these base maps including waterlines, sewerlines, storm drains, powerlines, planning data and emergency service data.

Now let's return to these often overlooked issues:

1. Mapping workload will increase during development phase.
   Manpower savings are almost always advertised as a reason for converting to computer mapping. Although it is usually true that time required for map editing will be reduced, the mapping work load may actually double for several years. Added to this doubled mapping effort is manpower required to coordinate and organize the program; i.e. selling the idea, funding for equipment, data conversion, contract management, and the inordinate task of keeping the mapping group progressing in an orderly manner.

2. A necessary, high level of inertia is difficult to maintain.
   Inertia is the single most formidable challenge to the mapping program. Management must be mobilized to support the project since they must approve budgets and assign manpower to organize the program. During this selling process, technicians and first level supervisors usually provide enthusiastic support. Later though, these same people will likely slow their own inertia because they suddenly discover the many changes that will impact each of them.

3. Task assignment is difficult.
   Assigning tasks to people is another challenge. People who have a mastery of software and ability to organize the project will very quickly bore of the actual work. Those who enjoy the screen input are very unlikely to be good at organizing the work. Similarly, using computer "friendly" people very likely implies that people with strong mapping backgrounds are set aside. After people are matched with tasks, assignment rotation and delicate scheduling is needed to encourage communication and avoid burn-out.

4. The demand for short term results must be considered even though it is a long term project.
   Finally, the program manager is always pressured to add "attractive" software functions. These are often disruptive or place a burden on mapping. Many of these tasks are more cost effectively solved outside of the mapping project.

After reminding the mapper of these challenges, it is also important to provide encouragement. After the project is running smoothly, the program manager, along with everyone who became involved, can look back and take pride in the accomplishments.

F.IV. DENVER WATER BOARD

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The Denver Water Department supplies water to approximately 65% of the Denver Metropolitan Area.

The Denver Water Department installed a mapping information management system (Synercom) in June, 1985. A six month pilot project was conducted beginning in July and ending in December 1985. The purpose of the pilot project was to develop and test the tools and processes required to fully implement the system and to develop a strategy for future use.

Currently, the Denver Water Department has completed creating the drawings and database for 450 of 1135 base maps. Completion of the conversion process is expected in early 1989. Numerous applications are in progress. Some of these applications are independent of the conversion process, such as creation of topographic maps, plan and profile drawings, and raw water reservoir capacity calculations. Some of the applications are already making use of converted maps such as extraction and analysis of 100 year old water pipes and extraction of data regarding critical pipe crossings of highways, rivers, and railroads.

Ultimately, the Department plans to link customer information files containing tap and billing information with the geographic database, add graphic capabilities to the network analysis process, develop plant maintenance files and vehicle routing routines, and a variety of other applications.

Eventually, the system will be available to sections and groups throughout the Department for accessing data and for creating their own applications. This should reduce redundancy, make more information available to more people, reduce time required to compile information, and allow us to perform tasks that previously were not practical.

In 1985 we committed approximately $1,000,000 to the project; since then we have spent perhaps another $500,000 with additional money needed in the future. This is a major commitment that will eventually impact nearly everyone in the Department as well as the public and the people we do business with.

During the pilot project we had a team with a full-time project director dedicated to the effort. People on the team came from various sections within the Department. After completion of the pilot project these people went back to their previous positions.

There were several factors that led us to where we are:

1. We have relied primarily on our own people throughout the process. We did use a part-time consultant during the pilot project but our philosophy was that, that person was here to assist; not to do. In other words, there was a feeling that this is going to be our system and we should know all there is is to know about it.

2. Prior to this, we learned a lot through visits to user sites, training, conferences, and we had some eager and enthusiastic people who were willing to work hard to achieve success.

3. Contrary to a "spirit of cooperation", we maintained a relatively low profile. We had struggled internally for ten to twelve years trying to get people organized and committed. We did not want to complicate the matter by trying to organize and sell the rest of the metropolitan area so we proceeded with our plan with the through that we would cooperate and share at a more appropriate time.

As you know, coordination requires a massive effort. On one hand cooperation and coordination sound good and should be pursued; however, they should not be allowed to slow down efforts already in progress. Perhaps the state's role initially should be to gather together appropriate people from appropriate agencies (such as this Forum) so that people can begin to learn about the industry and learn what others are doing; thus they can benefit from experiences of others and they can develop an implementation strategy taking other agencies into account. In this way the state takes on the role of facilitator. As facilitator, perhaps there could be a group that would identify issues and make recommendations on how they should be handled.

The Denver Water Department has shared its experience with people from across the country and some foreign countries. We will continue to work with a spirit of cooperation.

G. FEDERAL AGENCIES - PREFACE

Like in other sectors, the federal government's use of GI technologies is increasing markedly and it is also being reviewed by both the executive and legislative branches.

Various congressional offices have reviewed GI and related technologies, identifying cases of redundancy, increasing expenditures, and incompatibility. In 1982 the General Accounting Office concluded that $45 million was spent on computer mapping between 1970 and 1981 and identified areas of duplication. More recently, GIS expenditures in FY87 are estimated at $24-46 million and $46-68 million in FY88. The Congressional Research Service published a study in 1987 on the incompatibility of data generated by various state and federal agencies in the Yellowstone ecosystem. It recommended that a GIS framework be considered to manage these various data sets, and such a project is underway. The Office of Technology Assessment is conducting a study of federal information dissemination to state and local governments and will utilize the GI perspective in part of its work.

Federal agencies were directed by the Office of Management and Budget in 1983 to coordinate digital cartographic activities, resulting in the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC). Some analyses such as the enclosed GIS review and proposed exchange standards have resulted. A Federal Geodetic Control Committee (FGCC) exists with many of the same agencies, to help establish a densified geodetic network in coordination with state and local governments. The President's Management Message of March 24, 1987 identified 17 information systems with "major technological and program delivery significance as 'Presidential Priority' Systems". GI initiatives are included in two of the 17, and "in addition, the activities of other agencies with interest in GIS, will be reviewed." As revealed in Table II, a survey conducted by FICCDC 28 federal organizations either intend to or currently use GIS.

Colorado is emerging as the technical headquarters of GI activities in the federal government. As evidenced by the wealth of information presented by the panelists, the Interior (Department) Digital Cartography Coordinating Committee (IDCCC) has a subcommittee centered here. In 1987, the Bureau of Reclamation announced the move of its headquarters from Washington to Denver, resulting in approximately 300 new jobs here. Part of the cost justification for this move was that federal agencies can work together more effectively when located in close proximity to each other. Colorado governments have much to learn from and can build upon the work of these agencies. The state also has an opportunity to build its emerging regional and national strength with its increasing role as the federal government's GI technologies center.

G.I. U.S. GEOLOGICAL SURVEY

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The programs of the Geological Survey are designed to provided basic scientific data and analyses concerning water, land, energy, and mineral resources. The programs and missions included in the Survey's appropriation are conducted through three operating units: The National Mapping, Geologic, and Water Resources Divisions. There are two support service divisions, the Administrative Division and the Information Systems Division.

The USGS conducts its functions through extensive field organization of offices located throughout the 50 States and Puerto Rico. Denver, Colorado is the location for one of four regional centers. All five Divisions are represented at the center in Colorado.

The three operating divisions are involved in the use and production of digital data as well as utilizing Geographic Information Systems to carry out their work. The Geological Survey is in the process of establishing a regional GIS lab in Denver to support the various activities of the three Divisions.

To meet the demand for standardized digital cartographic data, the Geological Survey is digitizing base categories of information from its topographic maps and making these data available from the National Digital Cartographic Data Base in two forms:

1. Digital Line Graphs (DLG) are digital files consisting of plain metric (line map) information. Currently, the following categories of digital line graphs are being collected from 1:24,000-scale maps: Public Land Survey System, boundaries, hydrography, transportation, and a limited amount of topographic relief.

2. Digital Elevation Models (DEM) are digitized elevations horizontally spaced at 30-meter intervals throughout a 7.5-minute quadrangle.

The Public Land Survey System, hydrography, boundaries, and transportation features also are being digitized from 1:100,000-scale maps. Boundary, hydrography, and transportation features from the 1:2,000,000-scale sectional maps of the National Atlas of the United States of America are available in digital form for the entire United States. The data base also included elevation data from the 1:250,000-scale map series and land use, land cover, and geographic names information.

In a related area of activity, the Geological Survey has been delegated the lead role in implementing the Office of Management and Budget objective of fostering better coordination of all Federal digital cartography programs. In that role, the Geological Survey chairs the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC). The Geological Survey also coordinates digital cartographic data programs and activities within the Department of the Interior by chairing the Interior Digital Cartography Coordinating Committee (IDCCC). To further coordination at the regional level a Denver IDCCC subcommittee has been established. This subcommittee is chaired by the National Mapping Division's regional mapping center in Denver.

The Mission of the USGS's Water Resources Division is to provide the hydrologic information and understanding needed for the best use and management of the Nation's water resources for the benefit of the people of the United States.

The four Water Resources Division programs are the Federal Program, the Federal-State Cooperative Program, the Assistance to Other Federal Agencies, and the Non-Federal Reimbursable Program.

The Mission of the USGS's Geologic Division is to provide geologic, geochemical and geophysical information for other government agencies, and for the general public on land resources, on mineral and energy resources, and on geologic hazards of the Nation and its territories.

Extensive basic research is done continually on geologic processes and structure. Basic research is a major part of the programs and provides the capability needed to respond to emerging national problems. The five Geologic Division programs are the Geologic Hazards Surveys, Geologic Framework and Processes, Offshore Geologic Surveys, Mineral Resource Surveys, and Energy Geologic Surveys.

For information on availability of digital cartographic data from USGS contact:

U.S. Geological Survey
Rocky Mountain Mapping Center
National Cartographic Information Center (NCIC)
Building 25, MS-504
Box 25046, Federal Center
Denver, CO 80225
Telephone: 236-5829

For information on the activities and programs of National Mapping Geologic, Water Resources Divisions in the state of Colorado contact:

NATIONAL MAPPING DIVISION

U.S. Geological Survey
Rocky Mountain Mapping Center
Box 25046 MS-507
Bldg. 25 Federal Center
Denver, CO 80225
Attn: Lee W. Aggers
Special Assistant-Requirements
Telephone: (303) 236-5835
FTS 776-5835

GEOLOGIC DIVISION

U.S. Geological Survey
Rocky Mountain Mapping Center
Box 25046 MS-911
Bldg. 25 Federal Center
Denver, CO 80225
Attn: Any B. Coury
Geoscientific Staff Assistant
Telephone: (303) 236-5440
FTS 776-5440

WATER RESOURCES DIVISION

U.S. Geological Survey
Water Resource Division - Colorado District Office
Box 24046 MS-415
Bldg. 53, Federal Center
Denver, CO 80225
Attn: Richard O. Hawkinson
Associate District Chief
Telephone: (303) 236-4886
FTS 776-4886

G.11. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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Boulder, CO 80303
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NATIONAL GEODETIC SURVEY OVERVIEW

You may be familiar with NOAA's National Geodetic Survey (NGS) from its former days as the Coast and Geodetic Survey, in which it shared with the U.S. Geological Survey the production of topographic maps of the USA, and conducted a variety of other tasks related to mapping.

NGS continues as the national civilian surveying agency. Base map information such as geodetic leveling is a major activity of NGS. NGS collects and provides a variety of data related to horizontal and vertical control for the USA. Among these are traditional surveying techniques and the Global Positioning System (GPS). NGS is encouraging the implementation of GPS technology. In addition, NGS conducts gravity surveys as part of its program in geodesy. It is happy to advise people in these techniques. NGS is responsible for defining standards and specifications for gravity networks.

NGS provides a variety of information and services including vertical and horizontal survey control information, gravity anomaly values, control data containing base station descriptions and values, predictions of gravity at locations within the continental USA, and investigations into the improvement of systems and procedures for gravity acquisition and analyses. This information is useful for surveying, geodesy, and mineral and hydrocarbon exploration.

For further information, contact Richard S. Cohen at the mailing address above. Telephone (303) 497-6530.

NGDC OVERVIEW

NOAA's National Geophysical Data Center (NGDC) manages and disseminates public domain geoscience data pertaining to land, marine geology and geophysics, solar-terrestrial interactions, and to snow, ice, and Arctic regions. If you manage public-domain data in these fields, NGDC is here to serve you in making data more accessible to others. NGDC has similar international responsibilities, through operating World Data Centers for the National Academy of Sciences and the International Council of Scientific Unions.

Pertaining to land applications, NGDC manages topographic data with increased coverage at lesser resolution than that available from the U.S. Geological Survey (which stops at 1-degree quadrangles for the USA). From a composited set of digital elevation data for the conterminous USA, to coverage for much of North America, Europe, Japan, the Middle East, and the World at varying spatial resolutions. To complement this, we have detailed bathymetric data for USA coastal areas, as well as global bathymetric coverage at lesser resolutions.

NGDC also has public domain gravity, aeromagnetic, earthquake, engineering seismologic, exploration seismic, geochemical, satellite geophysical and other Earth Science data including some base map information.

As you may know, the Earth's magnetic field changes over the years, making rectification of historic land surveys with present ones. NGDC maintains a data base of present and historic magnetic field models that can assist the rectification of such surveys, among other uses.

OTHER NOAA ACTIVITIES OF INTEREST TO A COLORADO GIS ACTIVITY

NOAA has several other data centers, located outside Colorado. NOAA's NEDRES catalogue lists data available from anyone that wishes to be listed. Through these, NGDC can help you find climatological and other data, as well as satellite imagery for land, oceanographic and meteorological applications.

NOAA satellites can also be used for data transmission and relay. For example, John Kaliszewski of the State Engineer's office uses NOAA satellites to transmit stream gauge information from remote sites, to help monitor possible flood hazards. You might be able to use such inexpensive transmission capabilities, as well.

NGDC tries to keep aware of sources of data wherever they may be. Perhaps we can help you find such data for your needs.

OTHER ACTIVITIES RELATED TO GIS

As a data manager, supporting NOAA's role in a wide variety of environmental and related assessments, NGDC conducts research in data integration and remote sensing. We call this work "spatial data base management," though it could just as easily be called Geographic Information Systems and image processing (the latter of non-image data as well as of imagery).

Here are some existing and planned uses of image processing and GIS at NGDC. This is a relatively new and growing program, so various components noted below are in varying stages of development.

1. DATA QUALITY CONTROL

Greatly enhanced ability for QC of spatially referenced data. Many people accept data provided to them at face value, enter them into their own working data base, then apply the data for purposes never imagined by the producers of the data. THESE APPLICATIONS ARE OFTEN INAPPROPRIATE FOR THE DATA USED, AND MAY EVEN BE DANGEROUS! For example, did you know that the original digital elevation data were only crudely mentally interpolated between contour values? Did you know that other digital elevation data are digitized on profiles at 90-meter separations, then interpolated to 30 meter pixels without physical justification? What are the implications if you want to evaluate the area that might be flooded if the dam you are building bursts? You will be using the data inappropriately, and may be liable for the consequences. Data of almost all types have frequently ignored characteristics that affect their applicability to a given problem. Many artifacts can be at least partially compensated for, if the user knows what to do.

Such topics are fundamental to us. We are interested in the quality of data provided to us, and also in the characteristics of other data used in GIS investigations. GIS and image processing can help us here.

For example, colored images with digitally produced shaded relief base of potential field or topographic data help show artifacts in data collection and processing. Combined with other techniques such as data base management systems, statistical and graphic output tools, the data can be corrected or the error flagged, as appropriate.

There are other methods for quality control of spatial data. But these tend to be less effective without the processing and display capabilities of GIS/image processing. In addition, the GIS/image processing output can be done on the screen, to reduce "plot times," and can lead to NGDC products (displays of the data) that can be used as scientific and tools.

2. INTEGRATION OF EXISTING DATA SETS

NGDC has been building capabilities to develop integrated at a bases for other agencies with such systems. This can increase the usefulness of existing NGDC or other data, as well as increase its ties with other public agencies by helping them work with their own in-house date. GIS is essential for checking the registration and compatibility of integrated data sets, and is useful for illustrating their use. Indeed, GIS tools for data base construction are the fundamental tools for building integrated data bases.

NGDC has a planned support role to upcoming programs of environmental assessment, including the International Geosphere-Biosphere Program. For this task, it is gearing up the development of integrated data bases on a global scale. The same tasks apply at this scale as at more typical smaller scales of GIS development and application. However, as most GIS systems are not designed with such large-scale data bases in mind, surprising problems are encountered. We have been investigating these.

3. ROUTINE GRAPHICS WORK

Such work can be performed on the same hardware/software system, using data stored in the GIS, with some additional software work. We are often asked to provide illustrations of our data for publications, such as text books. We also prepare illustrations of various aspects of our data for professional journals. GIS and image processing are valuable supplements to traditional techniques of computer graphics for such work.

4. SPATIAL DATA MANAGEMENT TECHNIQUES FOR OTHER AGENCIES

NGDC is active in advising and providing services to other public agencies.

As much as possible, NGDC tries to keep up with developments in GIS elsewhere, to learn from others as well as offer its own abilities to others.

Several agencies working with GIS have used our help in data management and technique development. These include implementing enhancements to public domain software (often by adapting existing public domain algorithms from other programs), helping agencies to quantify qualitative decision-rules so that they can be applied in a GIS, and to helping agencies use GIS/image processing for scientific investigations.

One example pertaining to Colorado is assistance that should begin soon to the U.S. Army Corps of Engineers, which has responsibilities for protecting the environment on land under its care. The Corps is asking for our help in a hydrogeologic assessment in southeastern Colorado. Existing data from a variety of sources are being built into a data base, additional interpretations of these data by traditional methods will provide partial models for the assessment, then conceptual models for groundwater occurrence and quality will be converted into digital processing steps for the GIS assessment. Such work requires a knowledge of hydrogeology, related fields of GIS and image processing such as remote sensing, plus experience in converting conceptual models for processing in a GIS.

In another case, NGDC assisted NOAA's Environmental Research Laboratory, which conducts meteorological research in Boulder. Dale Gillette of EPL conducted a study of acid-rain parameters, which were compared by NGDC's John Kineman and Jeff Colby against Soil Conservation Service Major Land Resource (soil group) Areas in a GIS for assessment and display.

5. ADVISOR TO OVERSEAS AGENCIES

NGDC personnel have worked with the U.S. Agency for International Development to help develop GIS capabilities in Egypt.

Assistance to the United Nations Food and Agricultural Organization (UNFAO) has included advice on inclusion of NGDC topographic data in global evaluations forest systems. Other assistance to the UNFAO has included advice on the use of satellite imagery (including derived digital elevation data) for monitoring the movement of sand dunes in North Africa and for assessing the environmental impact therefrom.

6. TRAINING

NGDC has conducted workshops in a range of topics on scientific data management. It intends to include GIS and image processing in this list of workshops in the future. NGDC and the USGS are investigating holding a joint training workshop in GIS for the 100th anniversary Annual Meeting of the Geological Society of America, scheduled for late 1988. We are discussing the joint conduct of GIS training workshops with the National Park Service.

7. SCIENTIFIC RESEARCH AND DEVELOPMENT

NGDC has a rare combination of capabilities in science and data management. With a developed expertise in science and engineering, data integration, GIS, image processing, etc., we can exploit this combined expertise to do research.

One example of such research is the above mentioned study for the Corps of Engineers. Few organizations have the experience in hydrogeology, geological engineering, remote sensing, GIS and data management needed for such work.

Another example is proposed cooperative work with a number of Federal (and possibly state and local) governmental agencies to use data from a NOAA/ERL satellite receiving station in Boulder to detect forest fires in the western United States, and to provide daily information to land managers in near-real time. The satellite imagery can detect the heat source, the wind direction (from the direction of travel of the smoke plume), the location and size of the burned area, and the location of the fire within the burned area. The imagery can be processed for such characteristics, then compared with a data base of land ownership, and automatically notify the appropriate organization of the suspected fire and its progress. All this can happen within minutes of reception of the satellite imagery, which is received several times each day for the USA.

Crop, irrigation, forestry, snowpack, reservoir management, and other assessments can be assisted by using inexpensive satellite data from this new Boulder facility. You are more than welcome to explore possible uses of these data.

We also look at a GIS as a repository for spatial data to be searched upon by pattern recognition techniques ("machine vision") generated from an expert system as an entry into artificial intelligence of multilayered spatial data. Artificial intelligence will be severely limited in many fields without such capabilities.

8. SYSTEMS DEVELOPMENT

NGDC is interested in systems development in all aspects of scientific data management, including GIS and image processing. It is adopting and plans to enhance a combination of public domain (and perhaps private sector as well) GIS and image processing software systems. These include the NASA ELAS and the USGS/NASA LAS image processing systems, the U.S. Army Corps of Engineers GRASS GIS (with enhancements by Harvard University, the American Farmland Trust and others), and the National Park Services' SAGIS GIS. These are being brought together by their developers into a common UNIX workstation environment, and hopefully onto personal computers, as well.

Unlike some other public domain software, these systems are quite powerful, and will be even more useful when brought completely together. They are also supported well. NGDC plans to supplement the functionality with additional software development, including the adoption of other public domain software to these systems.

If you are considering implementing a GIS, you might want to investigate these exciting public domain systems. If you are a commercial vendor, these systems might help, as well.

CONCLUSION

In short, NGDC can provide data to assist many types of work. We also can refer you to other sources of data, and provide some types of advisory services. As our mandate includes the encouragement of a healthy private sector, there are services that we cannot provide to everyone (those that might conflict with existing or embryonic capabilities in the private sector). But, in some cases, such services can be provided to public agencies. Indeed, if you are looking of commercial/public-service applications in these areas, we may be able to help you.

For further information on NGDC data and services, contact David Hastings at the mailing address above, telephone (303) 497-6729.

NOAA's National Geodetic Survey and National Geophysical Data Center are part of a vibrant federal community working in Colorado. We are here to help you to the best of our ability.

G.111. BUREAU OF LAND MANAGEMENT

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Department of Interior
Colorado State Office
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Colorado's BLM has there areas of effort in developing automated geographic information:

1. An Automated Resources Database is presently being developed over western Colorado. Its primary uses to date have been for 5 year resource management planning and for project specific environmental impact assessment. It is evolving toward everyday use in such areas as range management, oil and gas leasing, and cultural resources inventories. The database so far consists of about 15,000 maps of various themes.

2. The Automated Lands and Minerals Record System (ALMRS) is a program throughout the Department of Interior undertaken in order to make update of land records easier and to make them more accessible to the public. BLM in Colorado presently has most of the state's mineral case records loaded into the system and is going to start land ownership data collection in 1988.

3. The Geographic Coordinate Database is our Cadastral Survey's system for storing surveyed coordinate data in Colorado. Record formats and information to be stored are under development. The goal, as with the other two branches of what BLM is calling the Land Information System, is to provide an easily accessible, accurate database for use in managing the public land.

In all of our efforts we have found that data collection is the most expensive proposition. We have reduced these costs where possible in Colorado through borrowing from state agencies, such as the Colorado Division of Wildlife, purchasing private sets of data when available, such as well spots and the Public Land Survey System, and working with agencies to develop data, such as Mesa and Jefferson County Survey Department.

Collecting a wide variety of data into a standard, automated form has forced our specialists who deal with the information to assess its accuracy, put it on a common map base, and to document its source. This, in turn, makes the data more transferable to other specialists and other agencies.

The immediate benefit of data sharing is to drastically reduce the cost to all agencies involved of obtaining and maintaining a usable database.

G.IV. ENVIRONMENTAL PROTECTION AGENCY

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The U.S. Environmental Protection Agency (EPA), Region VIII, includes the States of Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming. The regional office is responsible for administering several environmental statutes and programs in cooperation with state governments. These responsibilities require the acquisition, storage and analysis of large volumes of environmental data for the protection of public health and the environment and in support of regulatory decisions.

CURRENT AND PLANNED USE OF GEOGRAPHIC INFORMATION

Region VIII is currently in the process of developing a Geographic Information System for use with environmental data collected from traditional monitoring methods and remote sensing applications. The GIS will be used to organize, integrate and analyze the spatial distribution of environmental data ranging from ground water to atmospheric pollutants. The following applications are planned during the first phase of GIS implementation.

- Superfund site management
- Regional water quality assessments
- Acid deposition studies
- Ground water vulnerability assessments
- Air quality status and trends
- Exposure Assessments and risk analysis
- Applications with environmental modeling
- Applications with remote sensing technologies (Airborne Lidar and MSS data)

Region VIII is currently working with the EPA research laboratories in Las Vegas, Nevada, and Corvallis, Oregon as well as the U.S. Geological Survey in developing a GI system. Full system acquisition is planned for fiscal year 1988.

ADVANTAGES OF GI

The EPA and States spend millions of dollars each year collecting environmental data. Unfortunately, much of the data are not utilized within the current decision making process. A GIS represents a new and effective tool for making better use of these environmental data in regulatory decision making to protect public health and the environment. A GIS also allows EPA to evaluate the effectiveness of existing data collection activities and to integrate data bases. A GIS provides the mechanism to compare pollutant concentrations with exposed populations to evaluate: human health and ecological risks; effective pollution abatement; and optimal environmental management strategies. With a GIS, it will also be possible to communicate complex environmental data more effectively to the public, the regulated community and many other interested groups. A GIS is a cost effective tool for turning massive amounts of complex environmental data (collected at considerable expense) into useful environmental information.

MANAGEMENT APPROACH

Region VIII is approaching the development and implementation of a GIS in a phased manner. The GIS will first be applied to a small number of projects. The system will be expanded as technical experience, regional applications and hardware support grows. The implementation strategy includes working closely with other organizations in GI development and use.

The Agency has a proposed initiative to fund a GIS in every regional office by 1989. Currently, five regions and two research laboratories have or are developing GIS capabilities. The EPA research labs in Las Vegas, Nevada and Corvallis, Oregon have extensive GIS capabilities and have applied the system to several national research programs. The Corvallis lab applies a GIS to traditional environmental data while the Las Vegas facility is more focused on remote sensing applications. Both facilities could be helpful to Colorado's GI coordination effort.

Region VIII believes Colorado could play a very important role in GI development by serving as a state clearing house or library for geographic information. This service would promote data and information sharing and could eliminate costly duplication of effort as many organizations develop information within Colorado.

G.V. NATIONAL PARK SERVICE

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National Park Service
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969-0471

The National Park Service (NPS) began development of its integrated remote sensing, digital cartography and geographic information systems capability over 10 years ago. Currently, the NPS Geographic Information Systems Division, with a staff of 12, serves as the central NPS office for policy development and technical support for remote sensing and geographic information systems. The Division has responsibility for providing technical assistance to parks, Regions, and Washington offices in the construction and operation of geographic information systems data bases. The Division is responsible for development and dissemination of Servicewide standards and guidelines for remote sensing and geographic information systems activities; for technical consultation to parks and offices in hardware and software selection for remote sensing and geographic information systems applications; and for training of NPS personnel in remote sensing and geographic information systems software for use in remote sensing and geographic information systems software for use in NPS applications, and also serves as NPS' primary liaison with the remote sensing and geographic information systems activities of other agencies, universities, and other organizations both nationally and internationally.

Because a GIS contains computerized geographically referenced information about a park's resources, it can be used to help answer specific questions about park issues/problems. Further, its automated form makes it is very effective in entering, extracting, managing, analyzing and displaying information related to many resources (natural, historic, recreational, interpretation, and visitor and park support facilities). Therefore, it is a major goal for a comprehensive GIS implementation to make the GIS technology readily accessible in the park for daily use.

The Park Service is using GIS technology as a scientific basis for well-reasoned decisions in natural resource, cultural, fire, operations, and maintenance management. Examples of the size and complexity of the data bases range from the spatial distribution of coral communities in a 2 meter by 30 meter area at 200 locations at Biscayne National Park to more than 30 themes for the nearly 9 million acres within Wrangell-St. Elias National Park and Preserve.

Policy

We strongly believe that successful implementation of GIS in the NPS depends upon the park manager recognizing the value of the digital, spatial data base together with the manipulation, analysis, and display capability of a GIS as related to park management issues (resource, interpretation, operations, maintenance, etc.). A GIS developed to address a park manager's issues results in custom system which will take many forms (i.e. combinations of data, hardware, and software) and therefore designed to meet user needs. The NPS servicewide program defines policy and provides technical support for GIS development, acquisition, use and management to address issues that center around park needs. Activities that reflect NPS GIS policy includes the following:

- Technology Transfer - One of the most important missions of the GIS Division is the transfer of GIS technology to the parks, including related units, throughout the Service. This past year, after ten years of waiting and watching for the availability of suitable hardware, the division has engineered a major breakthrough in achieving this goal. A UNIX-enhanced PC has been developed and is currently being installed in nearly two dozen parks. At the same time, some parks, regions and related units are acquiring other configurations of UNIX-based workstations that suit both their GIS and image processing needs. Continued support, development, and enhancement of these systems occupy a major part of the division's time and energy.

- Data Base Construction Standards - Compliance with the data base construction standard is required. This standard is designed to assure data file exchange. Specifically, data bases that are constructed for a user, either park, region, or servicewide program, can be used by any other user's hardware/software configuration.

- Data Base Exchange Standards - The division supports and participates in the development of a national data transfer standard. Such a standard is expected to be issued in draft form for comment in January 1988.

- Data Base Construction - As part of its overall goal of transferring as much use of GIS technology as possible to the field, the division is encouraging parks and related units to carry out the administrative aspects of digitizing procurement. Under the technical supervision of the division, about a half dozen parks and related units are conducting their own procurement of digitizing services. We encourage and expect this trend to continue and grow.

- UNIX Operating System Standard - Servicewide standards recommend the use of the UNIX operating system (see discussion below).

- Park GIS designed to meet park needs

- Encourage use of public domain software

- o Training - With the installation of onsite systems in the parks and related units, the need and request for hands-on training is much greater now than in previous years. Establishing and giving training in the use of the division GIS's is an important and recurring activity for the division. To assist in this regard, the division has secured the support of the Interior Digital Cartography Coordinating Committee (IDCCC) for the production of three video tapes - Data Sources; Preparation of Mapped Information for Digitizing; and GIS Applications: "The GIS Tool Box".

Hardware

It is the opinion of the NPS GIS Division that neither hardware nor software should be mandated. By not dictating hardware, NPS GIS users are not precluded from taking advantage of the rapidly evolving and advancing hardware capabilities. What has been adopted along with data exchange standards is a "universal" operating system. that operating system is UNIX (a full fledged and robust implementation of AT&T and/or BSD versions). This operating system has now been implemented by nearly all hardware vendors and operates up and down an individual vendor's hierarchy or family of hardware systems. There is even action to issue a national standard for utilization of POSIX (a derivative of the UNIX operating system). A draft POSIX standard is expected to be issued in January for comment. Any new software conversions would need to be done only once and it would permit users to take advantage of advances offered by any hardware vendor. It will also facilitate the continued evolution of GIS and image processing software. This situation is very analogous with the advent of the PC's and DOS operating system. First there was primarily IBM and then the field exploded through the "standardization" of DOS. Now there are more hardware vendors and that hardware is more capable and less expensive. There is also a full range of very robust and user friendly software available for a myriad of things including GIS and image processing.

Software

An objective of the Geographic Information Systems Division is to assemble and support an interrelated set of software which can provide specific, complementary capabilities in overall GIS, digital cartography, and image processing, not only for Division activities, but for prospective NPS field users as well. A further objective is to make the components of this software "family" as hardware independent as possible and to provide prospective users with a range of possible hardware/software configuration alternatives, depending on the nature and extent of user requirements and to make this software readily available free to the user or at a nominal cost.

The Division recommends that any GIS and image processing software "family" should have the functional capability for:

GIS Software

- Data entry (through digitizing, tape, or diskette).
- Data display (including plots).
- Data editing.
- Data file management (linkage to data base management systems).
- Data analysis; including: reclassification functions, overlay functions (arithmetic, logical, and statistical), distance functions, neighborhood functions, and cartographic modeling.
- Capability to process digital topographic and plain metric data (DEM, DMA, DLG, etc.).

Image Processing Software

- Data entry (through digitizing, tape, or diskette).
- Data display (including plots).
- Data editing (including de-striping capability).
- Data file management.
- Data analysis; including geographic referencing (including multi-temporal and multi-thematic registration), derivation of training statistics, classification programs, statistical manipulation, polygon manipulation, spatial filtering, and some generalized GIS/data base analysis capability.

Combined GIS and Image Processing Software

Software should meet combined requirements of both image and GIS processing.

Although use of any or all of the software systems supported by the Division is not required of NPS GIS users, it is highly recommended for the following reasons: 1) a great level of user technical assistance and trouble shooting can be provided in-house by the Division staff for software that they use and support than for software with which they are not familiar; 2) user training in software can be provided by the Division staff, rather than by a third party; and 3) when enhancements are made to the nonproprietary software supported by the Division, these enhancements can be directly passed on to field users.

ELAS, GRASS, SAGIS, and TAE/LAS are the software systems which are currently (or are soon to be) supported and used by the GIS Division and they support the aforementioned functional capabilities. Prospective NPS GIS users are strongly urged to use these software systems. Because certain combinations of software systems may have unique hardware requirements, prospective users are urged to seek the advice of the Division.

G.VI. WESTERN AREA POWER ADMINISTRATION

Mr. Charles D. Landes, Chief
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231-1671

The Western Area Power Administration (Western) is a Federal agency responsible for the transmission and marketing of power across 15 Western States. Western maintains and operates more than 16,000 miles of transmission lines in providing its customers with economic and reliable electric energy.

To fulfill Western's mission, the following GEOGRAPHIC INFORMATION related activities are required:

I. Land Surveys by conventional and photogrammetric methods, as appropriate, associated with construction and acquisition of land rights for transmission lines, substation, and communication facilities.

Associated tasks:

- o Route Surveys:
  1. Determine location of centerline and other facilities being crossed
  2. Establish horizontal and vertical control based on state coordinate system
  3. Locate centerline PI's and structure locations
- o Land Surveys:
  1. Record research, for ownership and survey data including BLM, USGS, State, county and private sources
  2. Survey and Monument land corners of fee lands
  3. Determine location of ownership boundaries
- o Data formatted or products obtained:
  1. Large scale photo-based Plan and Profile Drawings for transmission lines and some access roads (Photos may be ratioed and rectified or ortho)
  2. Large scale topographic survey maps (small sites)

3. On basis of records search develop:

   a. Airport Clearance Plans and Profiles

   b. Communication and power company facilities maps

   c. Key maps (for Plan and Profile locality)

   d. Right-of-way plats and legal descriptions

   e. Schematic control and land monumentation diagrams describing coordinate locations, types of monumentation of land corners, and horizontal and vertical control stations

   f. Background data required from the survey contractor includes field notes and data tape with X,Y, and Z values for data captured during photogrammetric or conventional surveys.

II. Preparation of legal descriptions and tract plats:

   a. Prepared from data provided by survey contractors

   b. Data calculated and manipulated with Xcells CoGo

   c. A computer assisted design and mapping system presently being installed

III. Real Estate Information System:

   a. Includes acquisition data, dates, names, acreage, and locations

   b. Initially used to track ongoing acquisition status, and later used for land management and inventory information

G.VII. BUREAU OF THE CENSUS

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236-2852

Virtually all of the Census Bureau's activities have a foundation in Geography and rely heavily on the cooperation of other organizations both public and private. It is therefore fitting that the Census Bureau be involved in the Governor's Forum to promote cooperation in sharing information on Geographic Information Systems.

During the 1980 Census, our enumerators experienced difficulty in using the maps they had been provided. Many of the maps, although the best available, were out of date, especially in areas of the country that had experienced a great deal of rapid growth. In other instances, the only maps available were awkward to use in the field either because of the maps scale or physical size. After the 1980 Census the question was: "How do we avoid the same problem in 1990?" The Census Bureau looked to technology for an answer. This search has led to what is now referred to as the TIGER (Topological Integrated Geographic Encoding and Referencing) System. This system consists of a very detailed digital file. When complete, the TIGER file will include ALL roads, railroads, water features, feature names, political boundaries, and census statistical boundaries in the United States.

The TIGER file was made possible through a cooperative effort with the U.S. Geological Survey. USGS rasterized their 1:100,000 map series for use as a base map in TIGER. Simultaneously, were were busy manually updating maps using aerial photographs and the very best map reference material we could obtain from local governments and private mapping companies. Our manually updated maps serviced as the source for update of the digital file by hundreds of digitizing clerks. Once the massive digitizing operation is complete, the files will enter the output stage. This operation will produce the several million maps for the various Census field operations.

We are optimistic for the future of the TIGER file, the extensive applications within the Census as well as its potential as a tool for other organizations. The continued success of TIGER, like all Census operations will be dependent upon the cooperation of its users. The update maintenance of the file, feedback on its strengths and weaknesses, and potential enhancements are all functions which the user community will be encouraged to be involved in.

Huge investments have been made in the TIGER system already. These investments, however, will be dwarfed by the endless possibilities for applications by outside agencies and the benefits in all three aspects of Census operations: enumeration/collection, tabulation, and product output.

G. VIII. SOIL CONSERVATION SERVICE

Mr. Dale Holden
Soil Data Base Coordinator
Soil Conservation Service
Department of Agriculture
Colorado State Office
2490 West 26th Avenue
Denver, CO 80211
964-0471

Products Technical Specifications

a. Detailed Soil Survey Maps, 1:24,000 scale, revised 4/86
b. General Soil Maps, 1:250,000 scale, revised 4/86

Average costs for digitizing - $887.00 to $990.00 per quad

Data format and availability

Requests should consist of the kinds of computer, GIS software, and database software. Make requests to:

Sheldon G. Boone, State Conservationist
Attention: Dale Holden, Soil Scientist
Soil Conservation Service
2490 West 24th Ave., Bldg. A, Third Floor
Denver, CO 80211
Tel.: FTS 564-0480 or Com. (303) 964-0480

-OR-

National Cartographic Center
501 Felix
P.O. Box 6567
Fort Worth, TX 76115

Estimated cost for already digitized soils data: It is estimated that a full set of data for a soil survey would cost $400.00 if SCS has the needed format ready. A full set of data includes:

(a) The digitized data
(b) The Soils' 5/Soils' 6 flat file set from ISU for interpretative data

Interpretative Data:

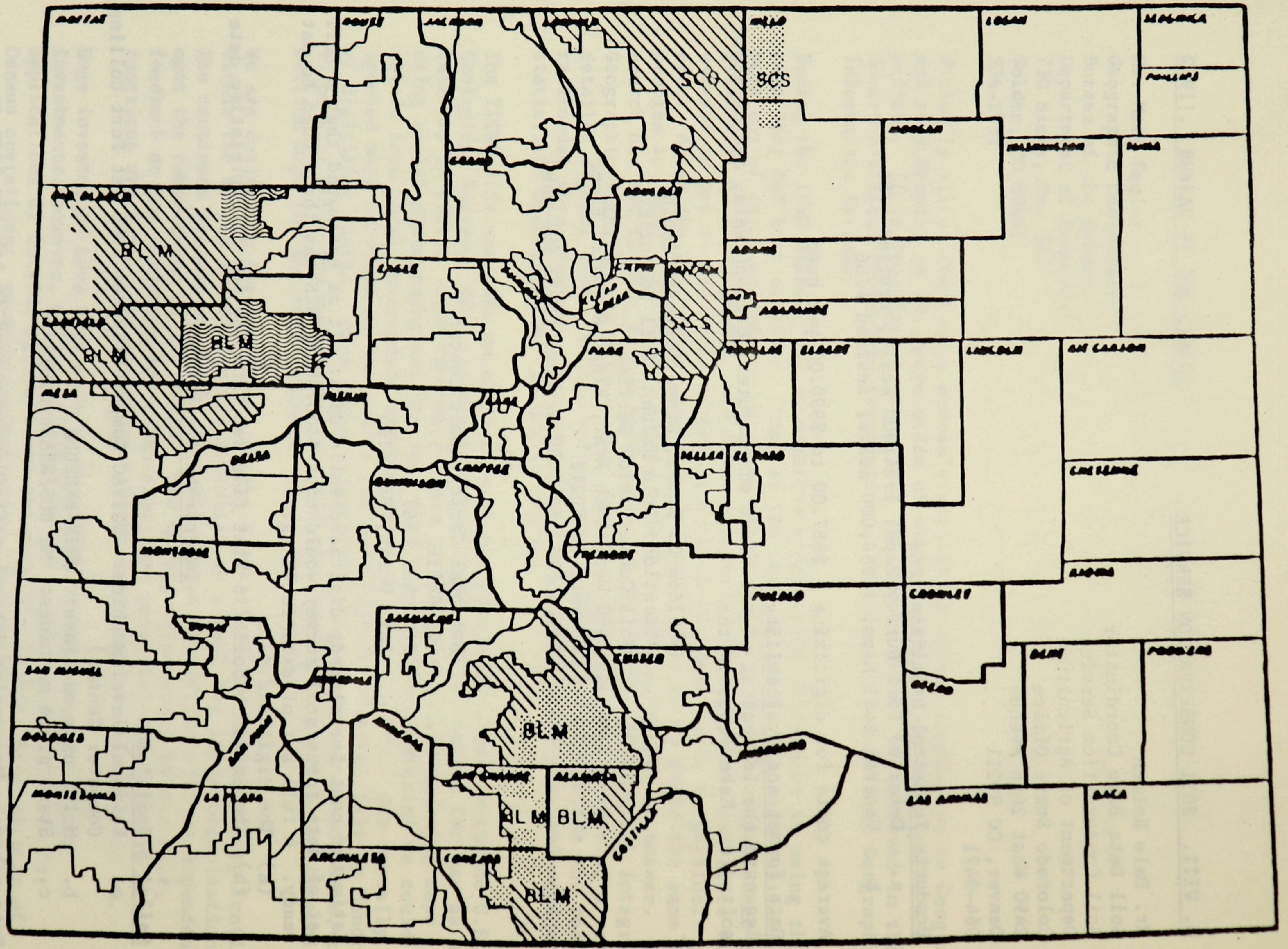
Soils' 5/Soils' 6

a. National level machine: UNIVAC Computer/System 2000 (at Fort Collins Computer Center)
b. Multi user machines: UNIX/PRELUDE
c. Stand alone machines: MS DOS/RBASE SYSTEM V

Data schema - Manuscript data of soil surveys stored in tabular form on interactive and/or relational databases which the user can create his own creation from the data.

Contact the above address for further information.

COLORADO


SCO
SCS
SCS
BLM
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SOIL CONSERVATION SERVICE
Dale Holden
(303) 964-0471

COUNTY/SOIL SURVEYS
JAN. 14, 1987

\\\\Full map sheets
▨ Partial map sheets
≋ Planned

DETAILED SOILS DIGITIZED

A. STATE AGENCIES - PREFACE

The importance of state governments in our nation's form of government is increasing both in general and in regard to Geographic Information. This is due to federal financial difficulties and delegation of responsibilities, growing state activism and self-governance to help improve their economic climates, and the fact that states create legal and operating environments for local governments. States can reference and access federal information and also build linkages with local governments to maximize the usefulness of local information. Virtually all states have some experience with GI technologies, especially in the management of natural resources, and computer aided design for transportation purposes. More recently, GIS are being used for other purposes such as demographic analysis and public health applications. Coordination efforts and directives have also been growing in recent years (See C.1. and Table I).

In comparison with other states, Colorado's state government has a history of much technological innovation including some national recognition, but less institutional reform and coordination. The state's four GIS initiatives, Natural Resources' Wildlife Division begun in 1974, Local Affairs Demographer's Office in 1980, Highway's Planning Division in 1986, and Health's Water Quality Division in 1987, have represented some of the first uses of this technology for these applications in any state government. State government has also funded the use of GI technology for specific projects (i.e., airport and supercollider proposals), but virtually no direction or ability to integrate this data with other resources has been developed. Colorado also had one of the first state mapping advisory committees (SMAC) as well as strong cooperative programs with federal agencies. Colorado was one of the first states with a state cartographer, but this position and the SMAC were abolished in 1983.

A reduction in emphasis in Colorado's state government is also evidenced by no formalized coordination group or authorizing environment for coordination between agencies. In addition, there are comparatively few trained personnel or active users and low capitalization of information exists in many agencies. Virtually no policies or interagency agreements exist regarding data classification, data exchange standards, data base construction, data responsibility or sharing of resources regarding information in general or GI.

Recent coordination efforts resulted in a 1986 Directory of GI for three state agencies, and a 1987 coordination project led and sponsored by Lowell B. Jackson; executive director of the Department of Highways. This initiative resulted in an inventory of past efforts, a review of current interests and activities, a working group of liaisons from state agencies as represented in part by the panelists, documentation of lessons learned from other states and governments, delineation of organizational options, and a draft directive for a GI Council with representation from all sectors in the state. The Department of Highways also sponsored this Forum to help identify activities, needs and interests in Colorado and determine state government's proper role and direction. The lack of an authorizing environment and financial resources, and Lowell Jackson's resignation, have ceased the Department's voluntary position as a lead agency in this area. The panelists however, attest to growing state agency activity in development of GI and use of related technologies, and an increasingly strong need for interagency and intergovernmental coordination.

H.I. DEPARTMENT OF ADMINISTRATION

Regina Kilkenny
Legislative Liaison
Department of Administration
1525 Sherman Street
Denver, CO 80203
866-3221

The role of the Department of Administration related to geographic information is threefold: the Commission on Information Management, the involvement in a state naming authority, and informal participation in a state inter-agency group. The Department of Administration is one of twenty state departments and its mission is to provide support services to other states agencies and governments (e.g., purchasing, risk management, telecommunications, archives and public records).

First, establishment of a Commission on Information Management was recommended by a group of private sector experts which studied the State's automated data processing and telecommunications in 1984. Senate Bill 246 was passed during the 1987 legislative session as part of the budget cutback package. SB 246 mandated 1) the elimination of the Division of Automated Data Processing in the Department of Administration, which served as a vendor liaison, provided technical assistance to state agencies, handled procurement of ADP equipment, and reviewed state agencies' ADP budget requests and 2) the establishment of a Commission on Information Management, a rule-making body in the Department of Administration.

The Commission is comprised of 8 private sector information management experts appointed by the Governor and 7 public sector members, including 4 Cabinet members from the Departments of Administration, Revenue, Highways, and Public Safety, the state court administrator, and two legislators (Representative Grampsas and Senator Schroeder).

The Commission's purposes are to oversee strategic planning and set policy for the state's information systems and to assure continuity in planning and controlling the State's investment in information systems. Staffing to the Commission was not provided through the legislation, and the Department is providing limited staff support at this time. The Commission is pursuing a variety of possibilities to assist with staffing needs.

Currently, the Commission is concentrating its initial time and efforts to understanding state government and its current level of computerization, as well as addressing agencies' ADP budget requests for Fiscal Year 1988-89.

Second, the State Archivist, Terry Ketelsen, is taking the lead on behalf of the state in forming the State Board of Geographic Names and working with state and federal agencies on that effort.

Finally, the Department of Administration is participating in an informal group of state agencies that is looking at inter-agency cooperation and coordination of geographic information management.

H.II. DEPARTMENT OF HIGHWAYS

Mr. Greg Fulton
GIS Manager
Division of Transportation Development
Department of Highways
4201 East Arkansas
Denver, CO 80222
757-9813

Approach

We foresee the Geographic Information System (GIS) serving as a "tool" for policy makers, management, and staff by providing better information for decision making. The GIS complements existing highway activities by portraying departmental statistical data in a geographic manner along with analytical capabilities. Our program is also designed to respond to changing conditions. Finally, the Colorado Department of Highways is developing its GIS to provide a framework for other agencies to use our information for their own purposes as well as to use information in a cooperative manner.

Current Status

The Colorado Department of Highways obtained its Geographic Information System (Arc/Info, MicroVAX) in September 1986. The first activity undertaken was the completion of a 1:500,000 scale map of the state, including all highways, in a digital format. This digital base was encoded with identifiers tied to the Department's mileposts, which identify each mile of state highway in the state. With this activity completed (March 1987), the Department is now able to relate information from numerous data bases relating to roadway characteristics (CORIS), Pavement Management System, Resource Allocation Project Prioritization, and deficient bridges. To date, we have produced over twenty different products, including a statewide traffic volume map, a statewide pavement condition map, a Denver Area pavement condition map, and district boundary maps (engineering districts, maintenance districts, strategies, and deficient bridge maps). The savings from these projects alone is substantial. On these projects, we have realized an overall cost savings of over 4:1 and a time savings of over 7:1. In addition to the savings realized in production time and costs, we are realizing other benefits as the GIS has allowed us to identify errors within our statistical data bases thus enhancing the accuracy of the information contained within those data bases.

The Department recently acquired a 1:24,000 scale data base (based on the USGS quadrangle series) covering the entire state. This data base will serve not only the Department's needs but the needs of other state agencies that require a geographic base for their work. This data base will allow us to do the more extensive analysis required for many of our projects that require greater detail and accuracy. The Department is working now with other state agencies on some proposed, joint efforts.

CDOH's Role in Coordination

CDOH has been actively working with other public agencies toward sharing its knowledge and resources to both maximize efficiency as well as minimize certain project costs. We see this effort continuing in the future.

Future

The GIS will be used as an analytical tool to determine correlations between data items. The GIS can also provide the capability to route oversize/ overweight vehicles and hazardous materials. The GIS may also serve in assisting our corridor analysis process by overlaying various types of information needed in the design process. Finally, the GIS will assist the Department in making better decisions on how to better allocate our resources and locate facilities.

H.III. DEPARTMENT OF NATURAL RESOURCES

Mr. Ron Cattany
Acting Deputy Director
Department of Natural Resources
1313 Sherman Street
Denver, CO 80203
866-3311

The majority of the information of the Department of Natural Resources is geographically based. The Department of Natural Resources is involved in four major resource areas:

1. Recreation: Wildlife and Parks
2. Land Management: State Land Board and Soil Conservation Board
3. Water: Water Resources and Water Conservation Board
4. Minerals and Energy: Mines, Mined Land Reclamation, Geological Survey, and the Colorado Oil and Gas Conservation Commission

Geographical information systems (GIS) are most useful from the multiple land use standpoint which is a major emphasis of our Department. The Division of Wildlife has been in the GIS business since 1974 with a system related to both wildlife habitat as well as wildlife control and management. Water Resources has a water data base which is geographically related, while not specifically designed as a geographic information system. The Mined Land Reclamation Division has a geographically based data base as it relates to permit tracking and hydrological data for the Yampa Valley. Geological Survey information is almost exclusively land based in terms of the maps and other types of information that is collected by the Survey. Their information relates specifically to land use analysis as shown by the recent work for the Super Collidor Super Conductor. The Oil and Gas Conservation Commission has established COGIMS (Colorado Oil and Gas Information Management System) which tracks well permits and royalty management from a geographic standpoint.

All of these activities have land use implications of particular relevance to local governments. It is important to the Department of Natural Resources that the information that is collected by these agencies is available for local land use decisions as it relates to geologic hazards, floodplain management, soil erosion, the infringement of oil and gas development on residential communities and geological implications of highway planning as seen at Muddy Creek and Roan Creek.

As a result of rapid energy development in northwest Colorado in the late 1970's, the Colorado Resource Inventory System (CRIS) was established for ten counties in northwest Colorado. The U.S. Department of Energy provided $400,000 to construct this system that is basically a geographic overlay of information related to wildlife, vegetation, minerals, cultural and land use, county's boundaries and planning regions. This system specifically dealt with the development of natural resources with regard to socioeconomics as well as competing resource development. The information included site information in terms of resource production, construction employment and water availability, community infrastructure, population allocation in terms of place of residence versus place of employment for commuting patterns, and maps of development and other types of input variables. The wildlife issues incorporated in the system included non-game species, game species, critical habitat and threatened and endangered nesting areas. This information was used extensively by both the U.S. Bureau of Land Management and a number of energy and oil companies to do both the economic analysis and the environmental impact analysis of a number of proposed projects in that area of the state.

The problem related to geographic information systems is one of ongoing maintenance, updating and use. Given the slump in the energy market in the early 1980's, the need for this type of sophisticated tool for assessing the competing uses of public and private land was not needed by the Department. At the time the U.S. Bureau of Land Management began to develop its WELLET Geographic Information System, the Department proposed to turn over the CRIS system to BLM. The major problem was compatibility of scale. The GIS being proposed by BLM was at a different scale than the CRIS system. However, BLM did provide grants to the Department in 1983 and 1984 to update the system. The system has not been used since 1985. However, there is a large amount of data which could be useful to another state agency, the private sector or the federal government in assessing the competing uses of limited resources in this part of the state.

The Department of Natural Resources continues to be interested in geographic information systems much more as a provider of information rather than a maintainer of a system. Specifically, the Department intends to make its information available for any state system that may be developed. It is important that the information provided is accessible to local governments for local land use decisions. The information is also useful to longer range environmental and land use planning. The information that is collected must be reviewed and consolidated to avoid duplication. In terms of maintenance of the system, compatibility of the GIS system between agencies and the medium of exchange of information is important. The Department feels that in this planning effort for geographic information systems, it is important to identify the non-technical issues and needs of the state for such a system specifically as it relates to policies, institutional arrangements and inter-organizational coordination.

The Department continues to be available to assist in the establishment of such a system that is both cost-effective and useful to the potential clients for the system.

H.IV. DEPARTMENT OF LOCAL AFFAIRS

Mr. Marv Koleis
Department of Local Affairs
1313 Sherman Street
Denver, CO 80203
866-3463

The demographic section of the Division of Local Government is responsible for generation, maintenance and dissemination of numerous databases. Our computer services, including a GIS, are operated on a bottom end minicomputer. These services range from general data processing for other divisions within the Department of Local Affairs, including the Health Data Commission, through support of existing programs in the Division of Local Government to the development of on-line database which can be dialed into and browsed via modems. To facilitate an understanding of the above mentioned databases and programs, I would like to give a brief description of them stressing the link to geography.

The Colorado Economic and Demographic Information System has nine databases on line, they are:

-County Profile
-County Economic
-County and Municipal Descriptive Data
-Vocational Educational
-County and Municipal Finance
-County and Municipal Enterprise
-County Population Projections
-U.S. Profile
-U.S.B.E.A. Two Digit Database

This data is obtained from various federal and state agencies. The U.S. Census Bureau and Bureau of Economic Analysis are the primary federal sources. The Departments of Health, Labor and Employment, Revenue and Education are the major state agencies that provide data in addition to our Department of Local Affairs. The system manager is Earl Hughes. Account numbers can be obtained by calling 866-3088 for the on-line service. Information can be obtained in hard copy by calling 866-3120. Hard copy printouts of 1980 census data is also available.

We are participating in various Bureau of the Census programs relating to the 1990 Census. The 1990 redistricting program's first phase, the Block Boundary Suggestion Program is one geographically related program, another is the Local Review Program. Our affiliation with the Census Bureau has been very beneficial and we hope to continue this very important association.

The Division of Local Government administers the allocation of Conservation Trust Func (CTF) or lottery monies back to local government entities. As the allocation is based on a "per capita" formula, it is necessary to have accurate population estimates for the state, county, municipal and special districts (those entities eligible for CTF monies). These estimates are produced using standard statistical and data processing techniques along with some GIS analysis techniques.

The development of digital geographic data layers in support of this program include county, municipal, special district and census tract/enumeration districts. Continued development of these layers enhances other services and application areas. Principal among these other services are the Electronic Atlas/Site Locator which generates custom maps at the state, county or census tract level and can generate an individualized report of the demographic composition around a particular site. A brochure on this service is forthcoming from the Division of Local Government.

The development/maintenance of these data layers and application of GIS technology will also enhance the Division's ability to review mill levy requests. The ability to answer the "where" questions around local government boundaries and overlapping jurisdictions is being greatly enhanced through the use of GIS technology. The integration of these layers, developed at 1:50,000 with other intermediate scale databases (i.e. 1:100,000 census products, 1:24,000 Highway Department database) will be one of the challenges of the future for our cartographic/geographic staff.

Our cartographic/geographic goals for the future include the continued development of the above mentioned data layers including school districts in support of existing programs. We will also continue development of our ability to use GIS technology to review mill levy requests and maintain access and distribution of traditional mapping/cartographic series:

-1:50,000 tape series film positives
-1980 and 1990 census reproducibles
-1:24,000 quad centered aerial/orthophotos

In addition, we continue development of on-line databases, and applications like the electronic Atlas/site locator. The development of GIS modeling capabilities in the network analysis area including redistricting and resource allocation, utilizing 1990 census products are planned.

These goals are tempered by our need to fulfill a legislatively imposed cash funding requirement. Within this context we have and will continue to contract our GIS services to other government agencies or private sector firms. Past efforts in this area include work for:

-Colorado Department of Institutions, Division of Mental Health
-Colorado Department of Natural Resources, Colorado Geological Survey
-Colorado Department of Agriculture
-Colorado Department of Education

We will continue to engage in cooperative efforts similar to our association with DRCOG, and internship programs like that with UCD geography department.

Generally stated, our goals are to meet the needs for data and services that our constituency request with more useful and timely information. We have also in the past offered our services to those interested in GIS technology though short demonstrations of our application areas and a discussion of GIS concepts. We will continue to be a resource to interested person in this area.

H. V. PUBLIC UTILITIES COMMISSION

Mr. James Spiers
Executive Secretary
Public Utilities Commission
1580 Logan
Denver, CO 80203
866-3198

As a matter of effective public management, most, if not all, governmental units have a significant need for an information system that provides a comprehensive base of material pertaining to the area under the jurisdiction of the governmental unit. Any such base, to be most efficient, should be tied directly to the geography of the service area. Depending on the authority and responsibility of the governmental unit, the base of information should provide material on the geography or topography of the area, the infrastructure of the area, and the socioeconomic characteristics of the area. From this base, more effective public management decisions may be made.

From the perspective of the Public Utilities Commission, any such system should contain the entire utility system infrastructure. Areas of jurisdiction cover the entire State and include:

- electric distribution systems
- gas distribution systems
- gas safety
- telecommunications systems
- water distribution systems
- regional transportation systems
- hazardous material/nuclear material routing
- rail safety

In utilizing the system, we should be able to evaluate utility management of the existing system operations and facilities and to evaluate future investments in the utility infrasturcutre.

As with any other governmental unit, the State faces an increasingly difficult job of allocating scarce resources. The most effective accomplishment of this requires strategic management of existing resources and strategic planning for future resource allocations. Accordingly, it is exceedingly important for all governmental units to make their public policy decisions with the same base of information and with full understanding of other units of entities and other policy decisions which may be affected by the decision.

To develop such a system, the State may take the lead in defining the system, evaluating availability and compatibility of existing systems, and identifying the manner in which these systems may most effectively, timely, and economically be integrated. Absent State leadership or private sector initiative, development of such a comprehensive system unfortunately may be impossible.

H. VI. HISTORICAL SOCIETY

Ms. Leslie Wildesen
Vice-President
Historical Society
1300 Broadway
Denver, CO 80203
866-2736

The Colorado Historical Society's Office of Archaeology and Historic Preservation has one of the earliest automated cultural resource data bases in the nation. It contains information about specific properties (historic buildings, archaeological sites, and other cultural areas) and documents relating to those properties. The system now is in-house, and runs on a C.Itoh mini-computer. Mapping still is manual, but the software will support graphics functions in the future (see attached system description).

The data base serves two main outside client groups, researchers and agency project managers. Scholars interested in the cultural heritage of Colorado use the data base to locate information about specific properties, to identify pertinent reports in our library, and to research a general area to ascertain the nature and distribution of its cultural properties. State and federal agencies are required to consult the data base to discover whether a proposed project may impact an important cultural property. Society staff also use the data base to provide technical assistance to these and other clients.

Because the information is exempt form the federal Freedom of Information Act, access to the data base is controlled; specific locational data are generally released only to persons with a genuine "need to know." There are several ways to compile the data so they may be shared more broadly in an interagency network, and we will be happy to work with anyone on a project of that type.

PROCEDURES FOR RECORDING AND TRACKING CULTURAL RESOURCES IN COLORADO

The Office of Archaeology and Historic Preservation (OAHP) currently employs a three step procedure for storing and tracking data about cultural sites in Colorado. The procedure consists of a mixture of manual files, maps and an interactive computerized data base.

Step One: Data on cultural resources (archaeological and historic sites) is submitted to OAHP by diverse outside entities including federal agencies, private consultants, contractors and the general public. The majority of this data is recorded on OAHP approved forms which provide some consistency in the type and amount of information given about each site.

Step Two: OAHP staff plots the location of the site on standard 7.5 or 15 minute USGS quadrangle maps. Legal locations such as township, range, section, street address and UTMs are used to accurately locate each site. Ideally, the site data is accompanied by a map recorder. At present, this series of maps represent the most accurate and complete locational information on cultural resources at OAHP.

Step Three: Data about each site is then entered into an interactive computer data base. The data base contains information about the location, function, cultural affiliation, management status, contents, environment and history of each site.

Once the data about cultural sites is entered into the OAHP system, it can be used to systematically and selectively retrieve information about cultural resources. By using both the maps and the computer, it is possible to quickly obtain a list of sites which meet a set of criteria specified by a searcher. The system allows for a great deal of flexibility in constructing the search criteria and is very responsive to ad-hoc queries as well as to producing standard reports. Once the list of sites in produced, it is possible to go directly to the OAHP files and retrieve the original site forms which contain a fuller narrative description.

H.VIII. DEPARTMENT OF HEALTH

Mr. Tom Tayon
Environmental Information Center Coordinator
Office of Health and Environmental Protection
Department of Health
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331-4516

The Colorado Department of Health has been working in the area of geographical information since 1982. In that year, the Water Quality Control Division initiated a project to map the location of water treatment and wastewater treatment plants in the state, as well as other pertinent environmental information related to the operation of these facilities. With a number of changes and adaptations, this system is still in use today.

At the present time, the Department is in the process of developing a number of projects that will have geographical information potential. A short description of these projects follows.

WATER QUALITY CONTROL DIVISION: Application of a Geographical Information System to Determine the Relative Vulnerability of Groundwater Resources in the Denver Metropolitan Area (Draft Report, December, 1987)

This report, done in conjunction with USGS and EPA, presents the results of a pilot study that evaluated potential GIS applications to estimate groundwater vulnerability in the Denver Metro area. Using an ARC/INFO system developed by the Environmental System Research Institute of Redlands, California, the study mapped: Geological features that affect aquifer vulnerability; well-water density and selected well-read protection areas; selected local sites of waste generation, storage and disposal; and selected land use practices. These items were mapped for a 120 square mile area.

The results of the study showed that GIS technology can be successfully used to calculate groundwater vulnerability. Several problems were cited that will be revised before the second phase of the project is completed. The problems, which appear to be common to most applications of GIS technology, include:

1. Compatibility of data from adjacent mapped areas (e.g., counties);

2. Converting data from other data bases into a format compatible with ARC/INFO software;

3. Availability of maps that can be readily digitized; and

4. The relative precision of maps produced by the ARC/INFO software.

The resolution of these problems should enable the Department to make much more effective use of the potential offered by available GIS technology.

DISEASE CONTROL AND ENVIRONMENTAL EPIDEMIOLOGY DIVISION: Craniosynostosis Study

For a number of years, physicians and other medical personnel have noted an unusually high number of reported cases of the disease craniosynostosis in Colorado. This birth defect, which affects infants and young children, causes abnormal development of the growth areas between skull bones known as sutures. This birth defect may physically interfere with brain development as the child grows. Developmental problems for the child may occur as a result.

The DCEED has initiated a study in order to determine if there is a relation between the reporting of this birth defect and selected environmental factors in the State of Colorado. In consultation with attending physicians, division staff mark the location within Colorado of the child's mother during pregnancy. As this location is recorded, the staff notes the elevation of the area as well as the source of the drinking water system (i.e., derived from groundwater or surface water sources) that was employed in that location. This data is again recorded, along with any pertinent information on the ambient quality of the drinking water.

In the first phase, all of the environmental information gathered, including the relative air quality of the various locations, will be digitized utilizing existing GIS software (for example, ARC/INFO). The second phase of the project will employ accepted statistical and epidemiological techniques in order to determine any possible relationship between incidence of the disease and the selected environmental factors. The project is expected to be completed by 1990.

This project is one of the first in the nation to utilize GIS technology in the study of epidemiology. If successful, it is likely that GIS software will play an increasingly important role in the study and prevention of disease.

HAZARDOUS MATERIALS AND WASTE MANAGEMENT DIVISION: Waste Site Inventory Project

Over the last few years, both the public and governmental decision makers have become increasingly aware about the problems associated with the management of hazardous wastes in the State of Colorado. Not enough was known about the types, locations and properties of the various wastes being created, treated and/or disposed of in the state to provide adequate levels of public health protection to Colorado's citizens. As a result of this increased awareness, the basic information needs of CDH personnel working in this area have grown tremendously.

In order to be able to deal with this burgeoning problem, the Colorado Legislature passed Senate Bill 109 in 1985. This bill allowed the State to participate in the federal Superfund program, which was intended to clean up the most seriously contaminated hazardous waste sites nationwide. In addition to expanding the Superfund program in Colorado, SB 109 mandated the creation of a waste site inventory project. This project was intended to mark the location of all places in the state where hazardous wastes had been disposed. It was felt that this information would allow the Health Department to begin work on eliminating the most serious sites, and to anticipate where future problems may occur. The Department began to register these locations, and made plans to have this information transferred to maps. Work on this project continues.

Since the passage of SB 109, however, a number of other areas where data must be gathered have been identified. These areas cover the following types of sites and/or processes that must be located and marked:

1. Sites of waste generation, storage and disposal activities, required by the federal Resource Conservation and Recovery Act (RCRA);
2. Sites of solid waste operations (landfills), both past and present;
3. Sites where the state and/or EPA has performed preliminary assessment and site inventory (PA/SI) activities, required by the federal Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund);
4. The identified Superfund sites in the state (currently, there are 13 such sites, which more anticipated);
5. Locations of all underground storage tanks (USTs) in the state (currently, there are 13 such sites, with more anticipated);
6. Location of all substantial amounts of hazardous wastes stored in the state, required by the Superfund Amendments and Reauthorization Act of 1986 (SARA, Title III).

As a result, the Division is expanding the activities undertaken by the waste site inventory project to include the creation of these database needs. Working both inside and outside the Department, the Division is collecting this data and has anticipated its placement onto GIS-type manipulation systems such as ARC/INFO.

Once this is accomplished, the Division will be able to use available GIS technology to anticipate, design and monitor hazardous waste management activities. In addition, this information will be used by the Department's other environmental health divisions to assist managers in their varied evaluations and decisions.

CONCLUSION

The technology offered by GI systems is expected to have a major impact on all areas of environmental health. The Department is continuing to explore the many ways to use this technology to improve the public health of the citizens of Colorado.

I. WRAP UP

The purpose of the Governor's Forum on Geographic Information was to present an overview of GI resources, activities, technologies, needs and interests in many sectors in Colorado. It also provided some lessons learned from efforts outside the State. The Forum revealed that each local government, business, state or federal agency, or other organization has its own unique individual needs, but also a common interest in developing a knowledge base about Colorado. It was learned that an increasing number of entities are adopting GI technologies to develop information resources for individual needs, and a great deal of money is being spent to do so.

The theme of the Forum was that coordination, cooperation, and joint development of GI resources can:

- Maximize resources, technologies and investments
- Improve accuracy, reliability, timeliness and cost effectiveness of information
- Minimize redundancy, incompatability, costs, and risk of incomplete or inaccurate information
- Serve as a unique focus and framework for the state's economic development efforts

The Forum was also held to charge the speakers and attendees with identifying the proper role for state government. The most repeated statement was that a framework and cleaning house is needed to coordinate GI in Colorado, and state government should be in this position and take a proactive, lead role. Other suggestions for state government's role included the following statements. It should keep track of what different entities are doing and what resources, such as data, people, training and funding are available. It should disseminate this information and facilitate cooperative projects. The state should establish data classification, collection, compatibility and exchange standards to allow information to be shared and compiled for statewide and multipurpose needs. A geographic and geodetic reference base is also needed for entities to reference and build their information upon. It was suggested that state government should first coordinate activities among state agencies, but should also build upon local government information.

Coloradans have many strengths, opportunities and benefits to realize from GI coordination. However, as Governor Romer stated in his opening remarks, GI development must be cost effective. As revealed by many of the speakers, it is cost effective for numerous individual projects and organizations. But, as governments here and elsewhere are quickly learning, these investments can be even more worthwhile if developed in cooperation with others for strategic, policy development purposes as well as operational ones. Such interorganizational projects, however, can be difficult to accomplish and impossible without the dedication of governmental leaders.

In the works of Ken Torp, Director of the Centers for Public/Private Sector Cooperation and Improved Public Management at the University of Colorado/Denver and ex-Chief of Staff for Governor Lamm, the "public policy challenge is as severe as anyone could think of." And, as concluded by Lowell Jackson, recent executive director of the Department of Highways, an "authorizing environment" is essential.

In summary, Colorado has numerous geographic information activities, resources and uses of related technologies, but with strong coordination needs and opportunities. The Forum was both an excellent testimony to this effect and a beginning to build Colorado's GI resources. Colorado can emphasize its unique, central location in the nation and emerging national center of the fledgling GI industry in its economic development efforts. The state's business community has recently organizing and related public sector groups are also increasing activities. Nurturing of these coordination activities and a proactive state role can achieve many positive results.

Many geographic information tools and resources are available and in use both in and outside the state. To maximize their value and usefulness, however, leadership, policies, authorizing environments and institutional innovation are needed. This need is particularly evident in Colorado.

Coloradans involved in various aspects of geographic information have many individual challenges and opportunities. By working together, both individual and statewide benefits can be achvieved, often with greater value for taxpayer investments. Direction and responsibility for effectuating geographic information coordination is in hands of governmental leaders, and particularly those in Colorado's State government. As evidenced by the excellent level of participation and support of the Forum, many Coloradans are ready, willing and able to assist state government in developing a much needed proactive role in coordination of Colorado's geographic information.

TABLE I

GEOGRAPHIC INFORMATION IN THE STATES

	NRIS[1]	GIS[2]	NCIC[3]	LEAD[4]	PARCEL MAP&ID[5]	OWN DATA[6]
ALABAMA	N	C	G	T	*2	L
ALASKA	N	N	U			
ARIZONA	N	N,L	N	T	*5	L
ARKANSAS			G		2	M
CALIFORNIA	I	N,L	U	N	*6	
COLORADO		C,N,T			*2	H
CONNECTICUT		N,N	N,U			L
DELAWARE			N	T		
FLORIDA		PL	U		*	L
GEORGIA	N		F		*6	H
HAWAII	N		A,U		*5	
IDAHO			H	G	*1	
ILLINOIS	N	N	G,U		*2	L
INDIANA		PN	U		*2	
IOWA	N		G		*	L
KANSAS		N	P		*1	H
KENTUCKY	N	N	G		*6	L
LOUISIANA	N		T		2	
MAINE		N	G,U			M
MARYLAND	N	A	G	G	*5	H
MASSACHUSETTS		N	U		*6	M
MICHIGAN	N	N	N	N	*2	
MINNESOTA	N	N,A	A		2	H
MISSISSIPPI	N	A	N		*6	
MISSOURI		PN	G	G	*2	
MONTANA	N	PN	U		3	M
NEBRASKA	N	N	N		*2	H
NEVADA			G		*5	
NEW HAMPSHIRE		A	U			M
NEW JERSEY	N	N,T	N	N,T	*5	M
NEW MEXICO	N	U	U		*1,3	
NEW YORK	I	N,N,O	T		*3,5	H
NORTH CAROLINA	N	N	G	N	*4	
NORTH DAKOTA	I	O	N			L
OHIO	N		N			H
OKLAHOMA			P		2	L
OREGON		N,T	R,U		*1	L
PENNSYLVANIA			G		*	L
RHODE ISLAND		N,A	U			H
SOUTH CAROLINA	N		N	A	*6	H
SOUTH DAKOTA	I				*2	H
TENNESSEE		N,U	G		*3,5	L
TEXAS	N	N,T	N	N	*	
UTAH	N	N,A	G		*	
VERMONT	I	U	U	O	6	L
VIRGINIA	N		N		4,6	L
WASHINGTON		N,T	R	N	*2	L
WEST VIRGINIA			G		*5	L
WISCONSIN		N	N		2	H
WYOMING		N	N		2	L

WARNECKE,1987

GEOGRAPHIC INFORMATION IN THE STATES

	CO-ORD STAFF[7]	NAMES BOARD[8]	SMAC[9]	OTHER[10]
ALABAMA	PS	1G	3G	
ALASKA	A,S	2A	I	
ARIZONA	A,PG	1L	1V	
ARKANSAS	S			
CALIFORNIA	O	3L	2N	G,L
COLORADO		4R		
CONNECTICUT		2G		
DELAWARE			1G	
FLORIDA	A,S,C	5O		
GEORGIA	S	R		L
HAWAII	S,C	2N	1V	L
IDAHO	A,C	2H	1L	G
ILLINOIS	O	U	4V	G
INDIANA				
IOWA			4G	
KANSAS	C	P	V	G,O
KENTUCKY		U		
LOUISIANA	A	U		
MAINE		1G	1G	G
MARYLAND	A		3G	
MASSACHUSETTS	A			G,L
MICHIGAN		1G	3G	G
MINNESOTA	A,O	2N		
MISSISSIPPI	A		V	G
MISSOURI	S		4N	G
MONTANA	A	1N	1G	O
NEBRASKA	A,S	4H		
NEVADA	C	2E	1G	
NEW HAMPSHIRE	A	5A		
NEW JERSEY	PA		1N	G
NEW MEXICO	PA	U	1U	G,O
NEW YORK	PA	2H		G
NORTH CAROLINA	S		4N	G,L
NORTH DAKOTA				
OHIO	A			
OKLAHOMA		2G		
OREGON	A,C	1H	1G	L,O
PENNSYLVANIA	A	2H		
RHODE ISLAND	A	4A		
SOUTH CAROLINA	A,S	4H	1A	G,L
SOUTH DAKOTA	A			
TENNESSEE				G
TEXAS		2L	4N	G
UTAH	C	1H	2G	G
VERMONT	PA	2R	1V	G
VIRGINIA	PA,O	1R,T		L,O
WASHINGTON	A,S,C	2N	2N	G
WEST VIRGINIA				
WISCONSIN	A,C	2N	2A	G,L
WYOMING		1N	I	

WARNECKE,1987

TABLE I KEY

GEOGRAPHIC INFORMATION IN THE STATES - KEY

USE OF TECHNOLOGY - SYSTEMS

1. Natural Resource Information Systems (NRIS)
   Location: N = Natural Resources agency
   I = Inactive

2. Geographic Information systems (GIS)
   Location:
   A = Administration/Planning
   C = Community/Local Affairs
   H = Historical Society
   L = State/Public Lands
   N = Other Natural Resources
   G = Geological Survey
   T = Transportation
   R = Archives/Libraries
   I = Inactive
   O = Other
   V = Varies

CENTERS, LEADS AND STANDARDS

3. National Cartographic Information Center Affiliates (NCIC)
   Location: See #2, U=Academic Institution

4. Lead Mapping Agency
   Location: See #2

5. Parcel Maps and Identification Systems

	Required	Recommended
Public Land Survey System:	1	2
State Plan Coordinates:	3	4
Map, Block, Lot Format:	5	6

* State requires ownership map

6. Quality of Ownership Transfer Data

   Key: H=High M= Medium L=Low

COORDINATION STAFFS AND GROUPS

7. Geographic Information Coordination Staffs
   Key: A = Geodetic Advisor
   C = Cartographer
   G = Geographer
   O = Coordinator/Other
   S = Surveyor
   P = Pending

8. Geographic Name Boards
   Location: See #3
   Directive: 1 = Executive Order
   2 = Specific Legislation
   3 = Agency Authority
   4 = Informal
   5 = Other

9. State Mapping Advisory Committee (SMAC)
   Location: See #3
   Directive: See #8

10. Other
    Key: G=GIS Users Group
    L=Land Records Reform Initiative
    O=Other Interagency Groups:
    Kansas Commission on Applied Remote Sensing; Montana Resource Data System Advisory Committee; New Mexico Geographic Information Council; Oregon Map Advisory Council

Source: Warnecke, Lisa, Geographic Information Coordination in the States in Proceedings of "Piecing the Puzzle Together: A Conference on Integrating Data for Decisionmaking", May 27-29, 1987. National Governors' Association, Center for Policy Research, Washington, D.C. CONF 8705147. (Reprinted and updated with permission)

TABLE II

May 20, 1987

SUMMARY OF GIS ACTIVITIES IN THE FEDERAL GOVERNMENT

The attached inventory of geographic information systems use in the Federal government was conducted and compiled by the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC). The FICCDC is an Office of Management and Budget established committee charged with coordinating and reporting on Federal agencies digital cartography activities. The steering committee is comprised of representatives from 11 departments and agencies, and regularly canvasses Federal agencies in order to gather necessary information on digital cartography activities and related spatial data technologies.

The intent of this inventory was to identify the scope of geographic information systems (GIS) use in the Federal community. Fifty organizations were asked to participate in the survey; thirty-one organizations responded. For the purpose of this survey, a geographic information system was defined as a computer hardware and software system designed to collect, manage, manipulate, analyze, and display spatially referenced data.

Highlights of the responses include:

-- 28 organizations either use or intend to use GIS; 11 of the organizations are using GIS operationally on a broad scope.

-- Seven organizations have a written published policy regarding GIS.

-- There are similarities in GIS use in broad terms, but a wide range of specific uses.

-- Nine organizations have classification standards; eight have data entry standards; and five have programs to manage standards.

-- Mini and microcomputers are the dominant hardware, with multiple manufacturers.

-- Overall percentage of use is almost equal between public domain and commercial software, with considerable diversity in program origin.

-- Most GIS activity is funded under mission related programs.

-- GIS related expenditures in FY 87 are estimated at $26-46M; FY 88-89 expenditures are estimated at $48-69M annually.

SUMMARY OF GIS ACTIVITIES IN THE FEDERAL GOVERNMENT

1. Which phrase(s) best describes the level of GIS activity in your Agency?

   a. Operational use on a broad scope.
   b. Operational use on a limited scope.
   c. Testing and evaluation use.
   d. Research and development activities.
   e. No current use but plan to use in the future.
   f. No requirements for GIS.

Agency	A	B	C	D	E	F	Comment
Department of the Interior							
BLM		X					
OSM					X		
FWS	X			X			
NPS	X*						*Explained in Survey
BIA	X						
BM					X		
BOR	X	X		X			
USGS	X			X			
Department of Agriculture							
FS		X	X				
ASCS						X	
SCS		X	X	X			
Department of Commerce							
Nat. Bur. of Standards			X	X			
Census		X					
NOAA (NOS)	X						
NOAA (NESDIS)		X					
Department of Energy							
Pacific Northwest Labs.		X	X	X			
(Oak Ridge) Martin M (contractor)	X			X			
Bonneville Power	X						
Department of State					X		
Housing & Urban Development						X	
Environmental Protection Agency			X	X			
National Capital Planning Comm.					X*		*Long range plans
Postal Service				X			
Tennessee Valley Authority	X						
Customs Service				X			
FEMA		X					
Agency for International Devel.	X						
National Archives						X	Unless a system was found that could be of benefit.
Department of Defense							
Corps of Engineers	X						
Engineer Topo. Lab.		X		X			
Nat. Aeron. & Space Admin.		X					

2. Has your Agency established a written published policy regarding GIS?

Agency	Yes	No	Comment
Department of the Interior			
BLM	X		
OSM		X	
FWS		X	
NPS	X		
BIA	X		
BM		X	
BOR		X	
USGS	X		Initial guidance furnished, est. a GIS Policy Task Force.
Department of Agriculture			
FS	X		
ASCS		X	
SCS	X		Draft policy
Department of Commerce			
Nat. Bur. of Standards		X	
Census	X		Policy is of a limited nature.
NOAA (NOS)		X	
NOAA (NESDIS)		X	
Department of Energy			
Pacific Northwest Lab.		X	
(Oak Ridge) Martin M. (contractor)		X	
Bonneville Power		X	
Department of State		X	
Housing & Urban Development			
Environmental Protection Agency			Currently under development
National Capital Planning Comm.		X	
Postal Service		X	
Tennessee Valley Authority		X	
Customs Service		X	
FEMA		X	FEMA is moving toward setting guidelines for State and local cooperation in developing a emerg/disaster GIS.
Agency for International Devel.		X	
National Archives			
Department of Defense			
Corps of Engineers		X	
Engineering Topo. Lab.		X	
Nat. Aeron.& Space Admin.		X	

3. What primary program of applications does GIS support in your agency?

Agency	Response
Department of the Interior	
BLM	Planning, inventory, monitoring, and management of lands, and mineral resources and renewable resources.
OSM	None
FWS	National Wetlands Inventory, research and development, natural resource management and planning.
NPS	Natural resource, cultural, fire, operations, and maintenance management--more detail in survey.
BIA	Supports a systems approach and rapid assessment methodology used by all renewable and non-renewable natural resource programs, i.e. forestry, range, transportation, agricultural, energy & minerals, water, fish, wildlife, recreation, and environmental.
BM	Opportunities exist but a GIS has not been implemented.
BOR	Land classification, Reclamation Reform Act of 1982, irrigation monitoring, baseline habitat.
USGS	Nat'l mineral resource assessment, regional earthquake hazard assessment, national mapping program, national earthquake hazard reduction program. National water quality assessment program, strategic and critical minerals, offshore geologic framework, landslide hazards, volcano hazards, others.
Department of Agriculture	
FS	To support natural resource planning monitoring, and project development.
SCS	Soil survey and conservation planning, soil interpretation maps and natural resource maps, river basin and watershed planning.
Department of Commerce	
Nat. Bur. of Standards	N/A
Census	All 1990 Census activities including but not limited to collection, control, mapping, geocoding and tabulation and publication of data.
NOAA (NOS)	Ocean and coastal assessments-GIS supports the preparation of atlases and responses to ad hoc queries concerning spatial distribution of water currents, pollutants & living & mineral resources.
NOAA (NESDIS)	Production of atlases showing distribution of climatic variables (ice, drought, temperature, precipitation, etc.).
Department of Energy	
Pacific Northwest Lab.	Analysis of multispectral remote sensing data, for energy and environmentally related uses.
(Oak Ridge) Martin M. (contractor)	Environmental monitoring and assessments, impact statements, regional modeling, transportation analysis, hazardous waste applications, regional siting.
Bonneville Power	Environmental impact analysis for transmission systems; resource inventory for facility siting.

Agency	Response
Department of State	None at the present time.
Housing & Urban Development	
Environmental Protection Agency	No specific programs/applications at this time.
National Capital Planning Comm.	None
Postal Service	Development of program for interactive modeling of Postal Servi delivery and collection routes.
Tennessee Valley Authority	Management of TVA lands and reservoirs; regional natural resour and economic development.
Customs Service	Unknown at present. May have possibilities in support of Custom border interdiction mission, air and land; also, possible intelligenc applications.
FEMA	National flood insurance program; national shelter survey progra national dam safety inventory, radiological emergency prepardne program, national civil preparedness program.
Agency for International Devel.	Effective use of information for the purpose of promoting economic development in the Third World while trying to sustain the fragile natural resource base.
National Archives	
Department of Defense	
Corps of Engineers	Environmental planning, and use management.
Engineering Topo. Lab.	Military terrain analysis, feature extraction, artifical intelligence research, development of tactical decision aids, environmental effects studies, research on terrain data display applications, development terrain data requirements, terrain data base production & maintenance, multispectral sensor exploitation.
Nat. Aeron. & Space Admin.	Primarily earth observations with some applications in the Planetar programs.

4. Data Standardization:

a. Do standard definitions and/or classifications exist in your agency for major thematic data categories used in GIS applications? Example categories could include: soils, timber, wetlands, geology, land use, transportation etc.

b. Do data collection standards exist for your agency (accuracy, format etc).

c. Does a program exist to collect and manage standardized data for use in GIS applications?

Agency	A		B		C		Comments
	Y	N	Y	N	Y	N	
Department of the Interior							
BLM		X	X			X*	*Under development
OSM		X		X		X	
FWS	X			X		X	
NPS		X*		X		X	*Individual applications drive class. schemes
BIA	X		X		X		
BM	X		X			X	Standards exist that could be used.
BOR	X		X			X	
USGS	X		X		X*		*DLG, DEM, LU/LC, geographic names, thematic data for national water summary, and for national water use program.
Department of Agriculture							
FS		X		X		X	
ASCS							
SCS	X		X		X		Details supplied with survey.
Department of Commerce							
Nat. Bur. of Standards	X		X			X	
Census	X					X	Did not answer "B"
NOAA (NOS)		X		X		X	
NOAA (NESDIS)		X		X		X	
Department of Energy							
Pacific Northwest Lab.		X		X		X	
(Oak Ridge) Martin M. (contractor)		X		X		X	
Bonneville Power		X		X		X	
Department of State		X		X		X	
Housing & Urban Development							

Agency	Response
Department of State	None at the present time.
Housing & Urban Development	
Environmental Protection Agency	No specific programs/applications at this time.
National Capital Planning Comm.	None
Postal Service	Development of program for interactive modeling of Postal Service delivery and collection routes.
Tennessee Valley Authority	Management of TVA lands and reservoirs; regional natural resource and economic development.
Customs Service	Unknown at present. May have possibilities in support of Customs border interdiction mission, air and land; also, possible intelligence applications.
FEMA	National flood insurance program; national shelter survey program, national dam safety inventory, radiological emergency preparedness program, national civil preparedness program.
Agency for International Devel.	Effective use of information for the purpose of promoting economic development in the Third World while trying to sustain the fragile natural resource base.
National Archives	
Department of Defense	
Corps of Engineers	Environmental planning, and use management.
Engineering Topo. Lab.	Military terrain analysis, feature extraction, artifical intelligence research, development of tactical decision aids, environmental effects studies, research on terrain data display applications, development terrain data requirements, terrain data base production & maintenance, multispectral sensor exploitation.
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   b. Do data collection standards exist for your agency (accuracy, format etc).

   c. Does a program exist to collect and manage standardized data for use in GIS applications?

Agency	A		B		C		Comments
	Y	N	Y	N	Y	N	
Department of the Interior							
BLM		X	X			X*	*Under development
OSM		X		X		X	
FWS	X			X		X	
NPS		X*		X		X	*Individual applications drive class. schemes
BIA	X		X		X		
BM	X		X			X	Standards exist that could be used.
BOR	X		X			X	
USGS	X		X		X*		*DLG, DEM, LU/LC, geographic names, thematic data for national water summary, and for national water use program.
Department of Agriculture							
FS		X		X		X	
ASCS							
SCS	X		X		X		Details supplied with survey.
Department of Commerce							
Nat. Bur. of Standards	X		X			X	
Census	X					X	Did not answer "B"
NOAA (NOS)		X		X		X	
NOAA (NESDIS)		X		X		X	
Department of Energy							
Pacific Northwest Lab.		X		X		X	
(Oak Ridge) Martin M. (contractor)		X		X		X	
Bonneville Power		X		X		X	
Department of State		X		X		X	
Housing & Urban Development							

Agency	A		B		C		Comments
	Y	N	Y	N	Y	N	
Environmental Protection Agency		X*		X*		X	*Under development and consideration.
National Capital Planning Comm.		X		X		X	
Postal Service		X		X		X	
Tennessee Valley Authority	X		X		X		Standardized only for TVA lands.
Customs Service		X	X*				*But unlikely for this application.
FEMA		X**		X*		X**	*Standard is USGS DLG3. **Under study & develop.
Agency for International Devel.		X		X		X	
National Archives							
Department of Defense							
Corps of Engineers		X		X		X	
Engineering Topo Lab.		X**		X**	X*		*ETL purpose is to test available standards. **Under research
Nat. Aeron. & Space Admin.		X		X*		X	*Accuracy is best available, format dictated by design.

5. Indicate the class of hardware used for GIS processing in your agency.

Agency	Main-frame %	Minis %	Micros %	Manufacturer(s)
Department of the Interior				
BLM		90%	10%	HP, Data general, Prime, IBM PC
OSM	--	--	--	Prime 9955 (Proposed)
FWS	10%	80%	10%	CDC, Data General, Prime, IBM
NPS	30%	20%	50%	Cyber, Prime, Masscomp
BIA		25%	75%	Data General, Prime
BM	N/A	N/A	N/A	
BOR	5%	90%	5%	Control Data, H-P, Prime, Tectronics
USGS	2%	88%	10%	Amdahl DCDB, Prime/Vax, PCAK, Sun, MVAX
Department of Agriculture				
FS		95%	5%	DG, H-P, AT&T
ASCS				
SCS		60%	40%	Data General, IBM, AT&T
Department of Commerce				
Nat. Bur. of Standards	N/A	N/A	N/A	
Census	50%	20%	30%	Sperry Univac, multiple vendors
NOAA (NOS)			100%	Sperry Micros, Apple Macintoshes
NOAA (NESDIS)		100%		Digital Equipment VAX II/780
Department of Energy				
Pacific Northwest Lab.	25%	25%	50%	Dec/VAX 11/780, DEC/VAX 11/55 + 11/70 DEC MicroVax II's Masscomp
(Oak Ridge) Martin M. (Contractor)	85%	10%	5%	IBM 3033, Modcompt, VAX 750 IBM PC/AT
Bonneville Power		100%		DEC/VAX
Department of State			100%	IBM AT
Housing & Urban Devel.				
Environmental Protection Agency	12%	85%	3%	DEC VAX + Prime
National Capital Planning Comm.	None	None	None	
Postal Service		100%		Digital
Tennessee Valley Authority		100%		Intergraph
Customs Service	N/A	N/A	N/A	
FEMA		90%	10%	DEC Data General, IBM PC/AT
Agency for International Devel.		90%	10%	Erdas, RIPS, DEC, Vacs
National Archives				
Department of Defense				
Corps of Engineers			100%	Sun & Masscomp, IBM/Cromemco
Engineering Topo. Lab.		25%	75%	VAX, Data General, HP, Sun, Microvax, Zenith
Nat. Aeron. & Space Admin.	30%	40%	30%	

6. Indicate the type of GIS Software used in your Agency

Agency	Public Domain %	Comm-ercial %	Major Software Name(s)	Vendor Name(s)
Deparatment of the Interior				
BLM	95%	5%	Moss family	IDIMS, Autocad
OSM	--	--		
FWS	80%	20%	MOSS, SAGIS, ARC/INFO	
NPS	95%	5%	MOSS, SAGIS, ELAS, GRASS	Aeronca, Atlas, Autocad
BIA	80%	20%	MOSS (under review), ARC/INFO	
BM	N/A	N/A		
BOR	20%	80%	AMS/MOSS/ MAPS, PIOS, SAGIS, TEKNCAD, IMIMS, ARC/INFO	Tetronics, ESLinc, ESRI
USGS	10%	90%	GIRMS, LAS, MIPS, ARC/INFO Geophysics, Image Proc., MOSS MapGen	ESRI, ERDAS, GIMMS
Department of Agriculture				
FS	80%	20%	MOSS, ARC/INFO, ERDAS	ESRI, ERDAS
ASCS				
SCS	50%	50%	COMARC, ODYESSEY, GEOBASED, ARC/INFO, MOSS, GRASS, AEGIS	Geobase, ESRI Autometric, Aeronca
Department of Commerce				
Nat. Bur. of Standards	N/A	N/A	N/A	N/A
Census	100%	0	Internally written software	
NOAA (NOS)	100%		Internally wirtten software	
NOAA (NESDIS)		100%		Odessey

Agency	Public Domain %	Comm- ercial %	Major Software name(s)	Vendor Name(s)
Department of Energy				
Pacific Northwest Lab.	75%	25%	GRASS, LAS (Pacific NW Lab.	International Imaging Systems and Symbols
(Oak Ridge) Martin M. (contractor)	50%	50%	ARC/INFO	ESRI
Bonneville Power		100%		Geobased Systems, Inc.
Department of State	None			
Housing & Urban Develop.				
Environmental Protec. Agency	15%	85%	ARC/INFO Internally written	ESRI
National Capital Plann. Comm.	None			
Postal Service		100%	AGIS	Interactive Systems Corp
Tenn. Valley Authority		100%		Intergraph
Customs Service	N/A	N/A	N/A	N/A
FEMA	80%	20%	Integrated Emer Mgt Info System (IEMIS)	FIA
Agency for Int. Development	5%	95%	ARC/INFO	ERDAS
National Archives				
Department of Defense				
Corps of Engineers	80%	20%	GRASS	ERDAS, DIPIX
Engineer. Topo Lab.	50%	50%	AMS, MOSS, GRASS	ESRI, USACERL, BLM, DBA, Autometrics
Nat. Aeron. & Space Admin.	50%	50%		

7. Do you currently have cooperative GIS programs/projects with other Federal, State or local agencies?

Agency	Yes	No	Cooperating Agencies
Department of the Interior			
BLM	X		BIA, USGS, FWS, BOR, COE, FS, SCS
OSM		X	
FWS	X		Agriculture, EPA, Army
NPS	X		NASA, 5 Universities, COE, FS, USGS
BIA		X	
BM		X	
BOR	X		USGS, COE, EPA, FWS, USFS, States of AZ, CA, UT, WY
USGS	X		USFS, NPS, BLM, States of IL and KY and others listed on the survey
Department of Agriculture			
FS		X	
ASCS			
SCS	X		Numerous States, USGS, TVA, CERL, EPA, DOT
Department of Commerce			
Nat. Bur. of Standards	X		Funded by NOS to facilitate implementation of digital carto exchange format with cooperation of USGS and DMA
Census		X	But to provide the framework, we use the USGS 1:100K through a cooperative program
NOAA (NOS)		X	
NOAA (NESDIS)		X	
Department of Energy			
Pacific Northwest Lab.	X		U.S. Army Ft. Lewis, WA
(Oak Ridge) Martin M. (contractor)		X	
Bonneville Power	X		USGS, EPA
Department of State		X	
Housing & Urban Devel.			
Environmental Protection Agency	X		USGS & FWS on a pilot basis in Regions III & IV
National Capital Planning Comm.		X	
Postal Service		X	
Tennessee Valley Authority	X		SCS, FS, EPA-numerous others listed on the survey
Customs Service		X	
FEMA	X		USGS, DOD, DOT, DOC; numerous states & cities listed on the survey
Agency for International Devel.	X		USGS
National Archives			
Department of Defense			
Corps of Engineers	X		NPS, DOE, SCS, USGS, NASA
Engineering Topo. Labs.	X		NPS, SCS, USGS, BLM, FWS Applications agreement w/Army, DIA, DOD activities
Nat. Aeron. & Space Admin.		X	

8. How are GIS activities funded in your Agency?

a. Line item appropriation %?
b. Other appropriated agency funds %?
c. Cost share funds from others%?
d. Other (describe)%?

Agency	A	B	C	D	Comment
Department of the Interior					
BLM		90%	10%		
OSM	N/A	N/A	N/A	N/A	
FWS	20%	70%	10%		
NPS	50%	40%	10%		
BIA	100%				
BM	N/A	N/A	N/A	N/A	
BOR		90%	5%	5%	
USGS		50%	20%	30%	
Department of Agriculture					
FS		98%	2%		
ASCS					
SCS		60%	40%		
Department of Commerce					
Nat. Bur. of Standards	N/A	N/A	N/A	N/A	
Census	100%				
NOAA (NOA)	100%				
NOAA (NESDIS)		100%			
Department of Energy					
Pacific Northwest Lab.	25%	50%		25%*	*Funds from other agencies
(Oak Ridge) Martin M. (contractor)		50%	50%		
Bonneville Power	50%	50%			
Department of State				100%	
Housing & Urban Devel.					
Environmental Protection Agency		100%			
National Capital Planning Comm.	N/A	N/A	N/A	N/A	
Postal Service	100%				
Tennessee Valley Authority		50%	25%	25%*	*TVA Power System Revenues
Customs Service	N/A	N/A	N/A	N/A	
FEMA	20%	60%	20%		
Agency for International Devel.		100%			
National Archives					
Department of Defense					
Corps of Engineers				100%*	*Mixture of a, b, c.
Engineering Topo. Lab.	100%				
Nat. Aeron. & Space Admin.					Funded within the project it supports.

9. Which funding level most nearly describes your agency's GIS expenditures?

Agency	FY 1987					FY 88-89 (Annual Estimate)				
	< $.5 M	$.5 -1M	$1- 3M	$3- 5M	> $5 M	< $.5 M	$.5 -1M	$1- 3M	$3- 5M	> $5 M
Dept. of Interior										
BLM				X					X	
OSM	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	
FWS			X					X		
NPS		X					X			
BIA			X						X	
BM										
BOR		X						X		
USGS				X						$7.7M
Dept. of Agriculture										
FS		X						X		
ASCS										
SCS				X					X	
Dept. of Commerce										
NB Standards	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	
Census					$7M					$8M then $6M
NOAA (NOS)			X					X		
NOAA (NESDIS)	X					X				
Dept. of Energy										
Pacific N. Labs		X					X			
Martin M. (Contr)	X					X				
Bonneville Pwr.	X									
Dept. of State	X					X				
House & Urban Dev.										
Environ. Prot. Agency		X					X			
Nat'l Cap. Plan. Comm.	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	
Postal Service										
Tenn. Valley Authority			X					X		
Customs Service	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	
FEMA	X						X			
Agency Int. Develop.										$10M
National Archives										
Dept. of Defense										
Corps of Engin.			X							X
Eng. Topo. Lab.		X						X		
Nat. Aeron. & Space Ad.										

10. Indicate your Agency's percentage of GIS expenditures for the following categories:

a. Operational use %?
b. Testing and evaluation use only %?
c. Research and development activities %?
d. Other (describe)?

Agency	a.	b.	c.	d.	Comments
Dept. of Interior					
BLM	99%	1%			
OSM	N/A	N/A	N/A	N/A	
FWS	85%	5%	10%		
NPS	70%	10%	20%		
BIA	95%		5%		
BM	N/A	N/A	N/A	N/A	
BOR	90%	5%	5%		
USGS	65%	5%	30%		
Dept. of Agriculture					
FS	5%	95%			
ASCS					
SCS	50%	25%	25%		
Dept. of Commerce					
NB Standards	N/A	N/A	N/A	N/A	
Census					Cannot break it down at this time since operation use will be in the future.
NOAA (NOS)	80%		20%		
NOAA (NESDIS)	80%	20%			
Dept of Energy					
Pacific N. Labs	25%	25%	50%		
Martin M. (Cont.)	30%	10%	60%		
Bonneville Power	70%		30%		
Dept . of State					None at the present time.
House. & Urban Develop.					
Environ. Prot. Agency		30%	70%		
Nat'l Cap. Plan. Comm.	N/A	N/A	N/A	N/A	
Postal Service			100%		
Tenn. Valley Authority	90%	10%			
Customs Service			100% *		*If application(s) can be identified; initial.
FEMA	10%	10%	80%		
Agency Int. Develop.	100%				
National Archives					
Dept. of Defense					
Corps. of Engineers	34%	33%	33%		
Engr. Topo. Lab	20%	20%	60%		
Nat. Aeron. & Space Ad.	5%		95%		

11. Does your agency make use of a video, primer, or any other educational/instructional material on GIS?

Agency	Yes	No	Describe if appropriate
Department of the Interior			
BLM	X		Training manuals, slides, video prepared by BLM.
OSM		X	
FWS		X	
NPS	X		Video produced by Interagency Fire Center Training Division plus a managers guide handbook.
BIA	X		Training cources ranging from 1-5 days.
BM		X	
BOR		X	
USGS	X		RMMC training program, slides, demos in USGS GIS research lab. A video demo is under development.
Dept. of Agriculture			
FS		X	
ASCS			
SCS	X		Video prepared by NPS & CERL and slides produced by SCS.
Dept. of Commerce			
Nat. Bur. of Standards		X	
Census		X	
NOAA (NOS)		X	
NOAA (NESDIS)		X	
Dept. of Energy			
Pacific Northwest Lab.		X	
(Oak Ridge) Martin M. (contractor)		X	
Bonneville Power		X	
Department of State		X	
Housing and UrbanDevelopment		X	
Environmental Protection Agency		X	
National Capital Planning Comm.		X	
Postal Service		X	
Tennessee Valley Authority		X	
Customs Service		X	
FEMA		X	Under development—contractor prepared tutorials on system.
Agency for International Devel.		X	
National Archives			
Department of Defense			
Corps of Engineers	X		Slide presentation (COE), video tutorial (NASA prepared)
Engineer Topo. Lab.	X		Training manuals (contract & in-house),slide presentation (in-house).
Nat. Aeron. & Space Admin.		X	

TABLE III

COLORADO STATE AGENCIES
GEOGRAPHIC INFORMATION

Identified Activities and Interests

Agency:	
Administration:	• Staff for new Information Commission
State Archives	• Voluntary lead for new Geographic Names Authority
Agriculture	
Corrections	• User of various Geographic Information
Education	• Manual maps and legal descriptions for all 176 school districts, cooperative program with Local Affairs to create digital database
Health:	
Personal Care	• Personal statistics identifiable by location, some to zip code or census tract level
Environmental Protection	• Water quality control division has GIS pilot project with USGS - WRD and EPA for ground water analysis. • Disease Control Division is creating digital data base to evaluate relationships between environmental factors and disease and regulate waste sites.
Higher Education:	
Historical Society	• Cultural resources are plotted on 7-1/2 or 15 minute USGS quadangle maps and being inputted in a new interactive textual database system.
Forest Service	• Information is plotted on 7-1/2 minute maps
Highways	• A GIS (Arc/Info, Microvax) is being instituted in the Division of Transportation Development with a predigitized database at 1:24,000 scale • A computer aided design system (Autotrol, Apollo) is used for project design in the Division of Highways and other GIS software is planned to be tested in 1988 • New, integrated mainframe system is in planning phase • A geodetic network has been recommended internally
Institutions	• Uses various GI, desires state reference base
Labor and Employment	• Increasing automation, information identifiable by jurisdiction, and considering worksite level detail for future
Law	
Local Affairs:	
Local Government	• Demographic Section has 9 online databases by jurisdiction, and maintains 1:50,000 tape series, 1980 and 1990 census reproductable and 1:24,000 quadcentered dengl/ortho photos. It works with the census Bureau, and uses its GIS (ArcInfo/Prime) to support all 5 sections of conservation trust fund monies and property tax mill levies. An Electronic Atlas/Site Locator generates custom maps and reports.
Property Taxation	• Sponsored automation grants for county assessors and is surveying mapping status to develop uniform program

Health Data Commission	
Military Affairs	
Natural Resources	
Oil and Gas Commission	• Textual System (customized Wang VS) based for all oil and gas wells and permits based on Public Land Survey with referencing to 40 acre resolution.
Board of Land Commissioners	• Textual system (Customized, Wang VS) linked with oil and gas system and including state owned surface leases, additional analysis underway
Mine Land Reclamation Division •	Automated permit tracing system (Wang VS) with GIS capabilities, including a videographic analyzer to quantify coal mine disturbances • Jointly developed hydrologic database on Yampa Valley with BLM and USGS-WRD (Prime)
Division of Wildlife •	GIS (SAGIS, CSU Cyber link) and image processing (ERDAS, AT&T PC) for habitat management and control
Geological Survey •	Graphics system (IBM PC) to model activity and maintains information on water, oil and gas logs
Water Resources Division •	Satellite monitoring system (VAX 1170) for over 160 streams with data transmitted from over 1500 sites for water management and dam safety projects; with other capabilities. • SB 200, adopted in 1987, required development of cash funded groundwater information system, and system under development.
Personnel	
Public Safety	
Regulatory Agencies:	
Public Utilities Commission	• Maintains some information on utilities and transportation and has interest in working with utilities creating digital databases
Revenue	• Tax profile of state and federal income tax, and sales tax levies, revenue and retail sales by jurisdiction for state collected taxes
Social Services	• Information regarding programs can be referenced by jurisdiction or zip code

Information compiled by Lisa Warnecke from reports given by agency representatives at State Agencies GI Coordination Project meetings held on July 24 and August 12, 1987, completed "Colorado GI Resource Inventory" forms and other voluntary reports.

TABLE IV

GEOGRAPHIC INFORMATION IN COLORADO COUNTIES

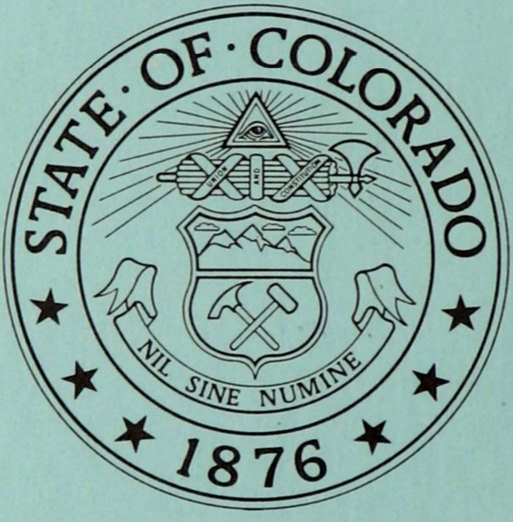
DIVISION OF PROPERTY TAXATION				COLORADO COUNTIES, INC.			
COUNTIES	SURVEYED	MAPPING RESPONSIBILITY	PARCEL MAPPING	RESPONDED	USE OF AUTOMATION	SOFTWARE	SURVEY HARDWARE
ADAMS				X	D		
ALAMOSA				X			
ARAPAHOE				X	P		
ARCHULETA	X	A	C	X			
BACA							
BENT	X	A	C	X			
BOULDER				X	D	Arc/Info	Prime/IBM/Techtronix
CHAFFEE	X	A	C	X			
CHEYENNE							
CLEAR CREEK					X		
CONEJOS				X	P		
COSTILLA							
CROWLEY							
CUSTER				X			
DELTA				X			
DENVER (Water Dept.)				X	F	Synercom	VAX 780
DOLORES	X	O	C				
DOUGLAS				X	F	COMARC	DataGeneral/Prime
EAGLE	X	A	C	X	P		
ELBERT							
EL PASO							
FREMONT				X			
GARFIELD				X	A		
GILPIN							
GRAND	X	A	P				
GUNNISON				X	F	COMARC	DataGeneral/Techtronix
HINSDALE							
HUERFANO				X			
JACKSON	X	A	C	X	F	COMARC	DataGeneral/Techtronix
JEFFERSON				X	F	Inhouse	Honeywell/Techtronix
KIOWA							
KIT CARSON							
LAKE				X			
LA PLATA	X	O	C	X	A		
LARIMER				X	F	MARS(300KT)	Digital/Techtronix
LAS ANIMAS	X	A	P				
LINCOLN	X	A	C				
LOGAN				X			
MESA	X	A	C	X	D		
MINERAL				X			
MOFFAT	X	A	C	X			
MONTEZUMA	X	A	C				
MONTROSE				X	P		
MORGAN							
OTERO	X	O	C	X			
OURAY	X	A	C				
PARK	X	O	N	X			
PHILLIPS				X			
PITKIN				X			
PROWERS				X			
PUEBLO	X	A	C	X	P		
RIO BLANCO	X	O	P	X	A		
RIO GRANDE							
ROUTT	X	A	N	X			
SAGUACHE				X	A		
SAN JUAN	X	O	C				
SAN MIGUEL	X	O	C	X			
SEDGWICK							
SUMMIT	X	A	C				
TELLER	X	A	C				
WASHINGTON							
WELD				X	P		
YUMA							

A = Assessor
O = Other
C = Complete
P = Partially Complete
N = None

F = Functioning Digital System
D = Development phase
A = Other automated systems
P = Planning for system

Source:

1. Colorado Division of Property Taxation, Survey of Mapping in County Assessor's Offices, partially complete, 1987
2. Survey of Geographic Information in Colorado Counties, 1987



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